MARINE ENGINEERING.

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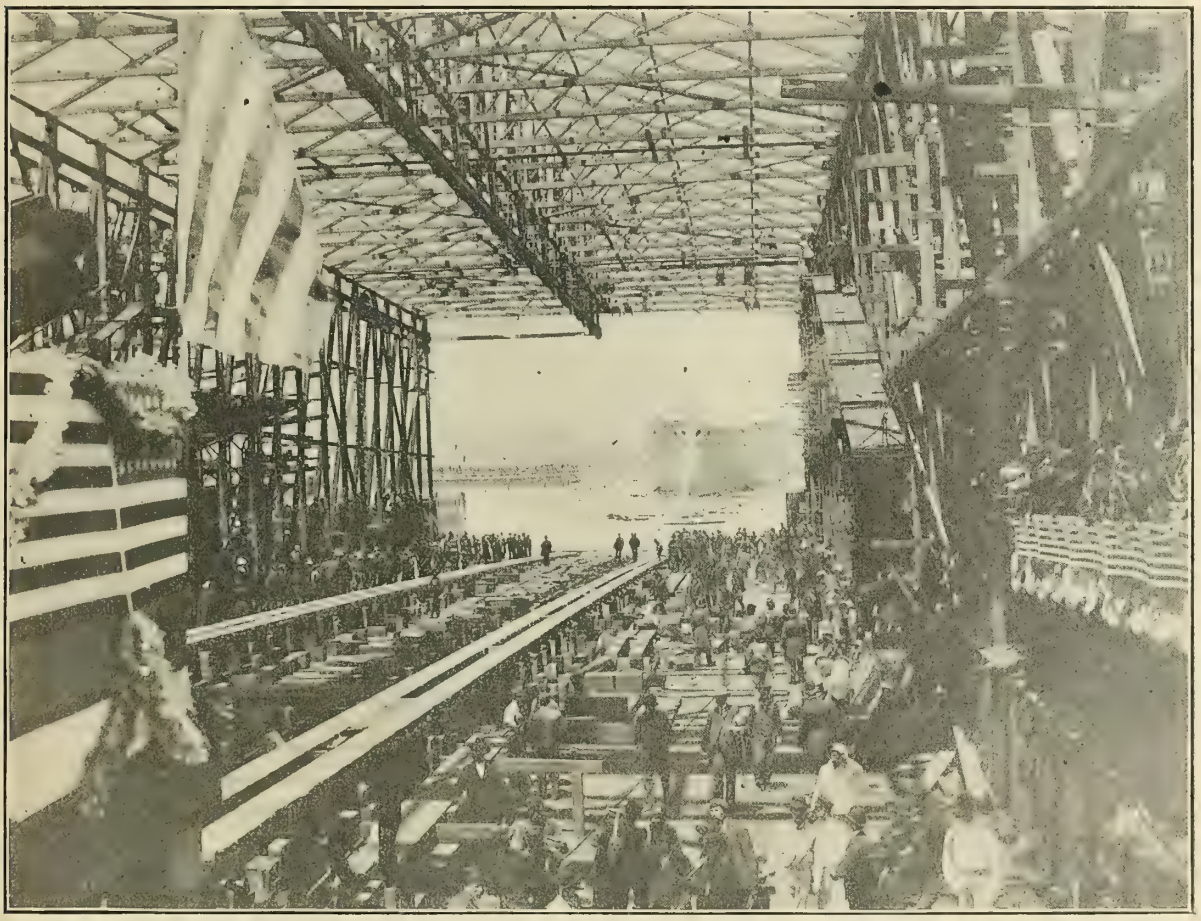
LAUNCH OF THE BATTLESHIP OHIO.

On May 22 the battleship *Ohio* was launched at the Union Iron Works, San Francisco, in the presence of President McKinley, several of the members of his cabinet, and a great crowd of spectators.

Length on load water line	388 ft. 0 in.
Beam, extreme	72 ft. 2 1-2 in.
Draft, mean	23 ft. 6 in.
Corresponding displacement	12,300 tons
Load displacement	13,500 tons.
Speed	18 knots.

The hull is protected by an armor belt 7 ft. 6 in. broad



BATTLESHIP OHIO AND LAUNCHING WAYS AT UNION IRON WORKS.

The *Ohio* is one of the three battleships authorized by Congress May 4, 1898; the others are the *Missouri*, now building at Newport News, Va., and the *Maine* now being built at Philadelphia by Wm. Cramp & Sons. The contract price of the *Ohio* was $2,899,000 exclusive of armor and armament. The general dimensions are:

and 11 in. thick above the water line, tapering to 7 1-2 in. at the bottom. This extends on both sides from abreast the forward barbette to abreast the after barbette, and at the ends 9 in. diagonal armor runs across the ship. Casemate armor 6 in. thick is worked in on the sides from the armor belt to the upper deck. A cofferdam

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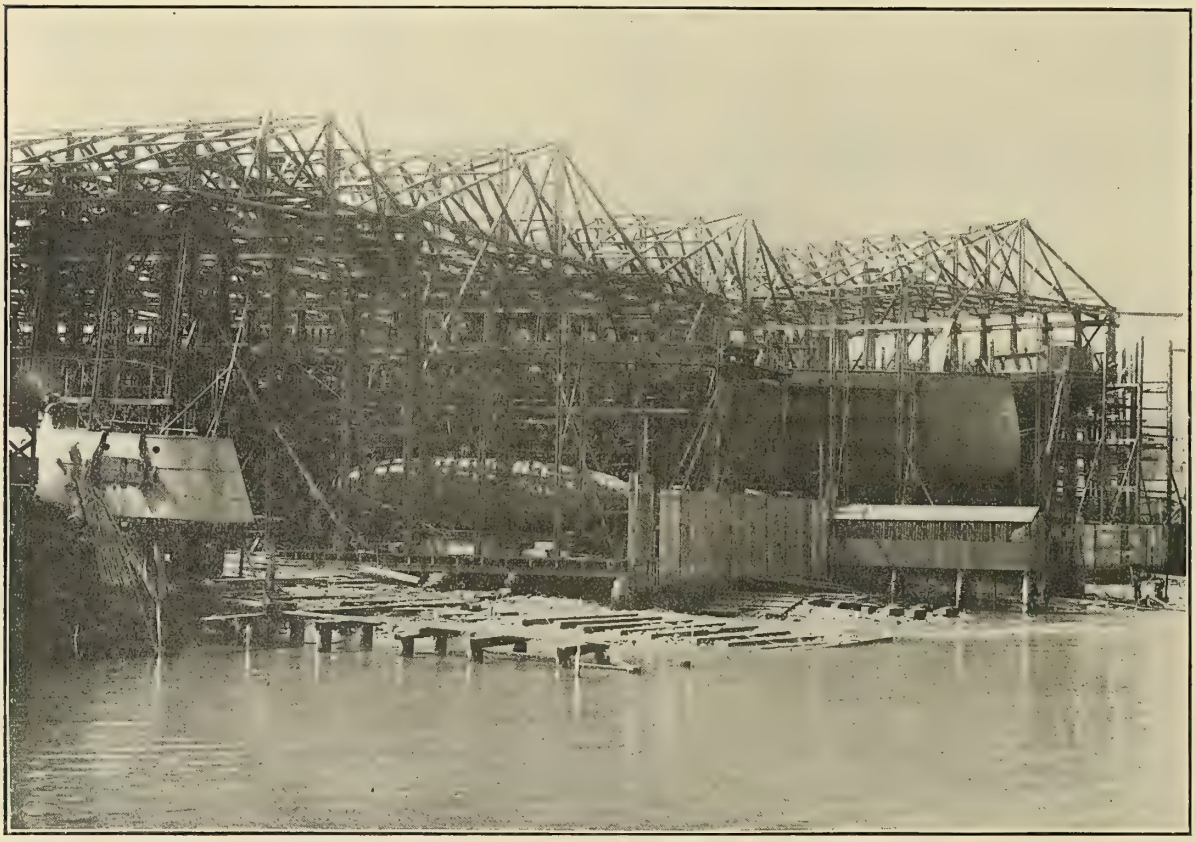
filled with cellulose extends from stem to stern along the water line. A protective deck covers the engine and boiler space and is 4 in. thick on the slope to the forward barbette, 2 3-4 in. thick on the flat and 3 in. thick on the after slope.

The main battery of the *Ohio* consists of four 12 in. 40 caliber breech loading guns placed in two turrets, one forward, one aft on the center line, and sixteen 6 in. rapid fire rifles, of which ten are within the casemates, two forward on the berth deck in sponsons with 6 in. armor, and four are on the upper deck. There are two military masts, the foremast located over the conning tower which has 10 in. armor. From the forward conning tower a vertical tube 12 in. inside dia. and 7 in. thick, extends below the protective deck for conveying



WATERFRONT AT UNION IRON WORKS, SHOWING STERN OF OHIO.

the electric signals, and speaking tubes. The turrets are operated by electricity.

The two engines are located in separate watertight compartments and are of the triple expansion, inverted, four cylinder type, with cylinders 35 1-2 in., 53 in., 63 in. and 63 in. dia. by 48 in. stroke. There are twelve Thornycroft boilers furnishing steam at 250 lb. pressure.

When in commission the *Ohio* will carry a complement of 35 officers and 511 men.

The illustration on page 261 was taken at the time of the launch, from the head of the ways and shows the *Ohio* afloat. The building ways at the Union Iron Works are covered with a removable roof as described in detail in MARINE ENGINEERING for May, 1900. This construction can be seen in the illustration on this page. The stern to the extreme left is that of the torpedo boat destroyer *Paul Jones*, next is a submarine boat, and to the right is the stern of the *Ohio*.

SHIPBUILDING AT CADIZ is being revived and the shipyards enlarged.

U. S. S. WISCONSIN.—The Government acceptance trial trip of the battleship *Wisconsin* was satisfactorily completed at San Francisco on June 16. With natural draft a speed of 16.45 knots was maintained for two hours, and the average speed for forty-eight hours was 15.3 knots.

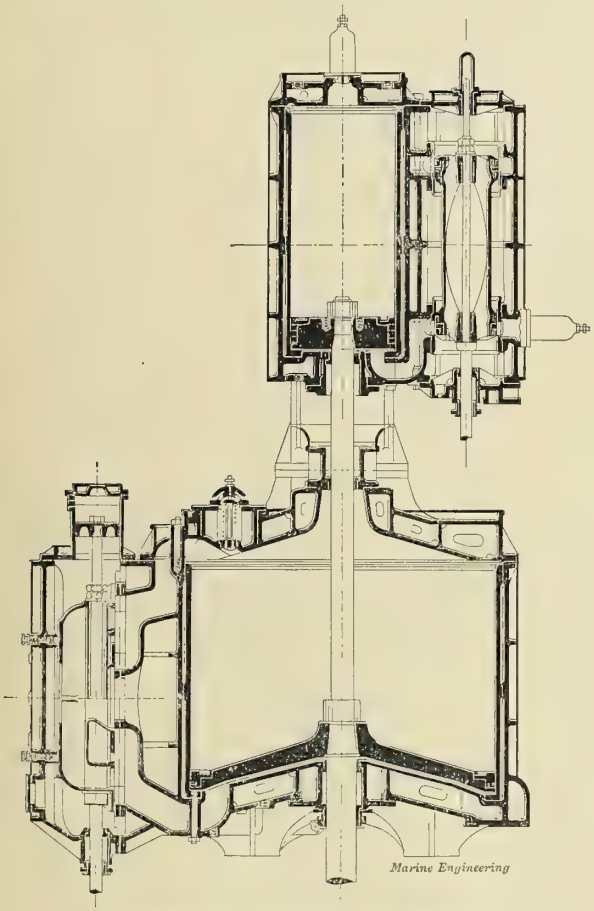
TRIAL TRIP U. S. S. ILLINOIS.—An average speed of 17.31 knots was maintained on the official trip of the battleship *Illinois* on June 13, over the Cape Ann course. The conditions of weather and sea were favorable to speed, and the ship covered the first 33 miles in 1 hour 54 min. 4 sec., averaging 17.36 knots with a maximum of about 17.8 knots. The return trip was made in 1 hour 54 min. 46 sec. at an average speed of 17.31 knots. These figures are not corrected for tidal observations, which, however, will not materially change the results. This makes the *Illinois*, built by the Newport News Shipbuilding and Dry Dock Company, the fastest battleship in our Navy. The other two ships of her class, the *Alabama*, built by the Wm. Cramp and Sons Company, and the *Wisconsin*, built by the Union Iron Works, made on their trial trips 17.01 and 17.13 knots respectively.

THE TWIN SCREW EXPRESS STEAMER DEUTSCHLAND.

Built By Stettiner Maschinenbau-Aktiengesellschaft Vulcan.*

(*Continued from page 246.*)

On the forecastle deck forward are mounted two anchor windlasses driven by a double cylinder steam engine of 17 in. cylinder diameter by 14 in. stroke, and the forecastle deck as well as the poop deck have each two warping windlasses, which have a hand gear as well as steam gear. Those on the forecastle are each driven by a double cylinder engine of 15 in.

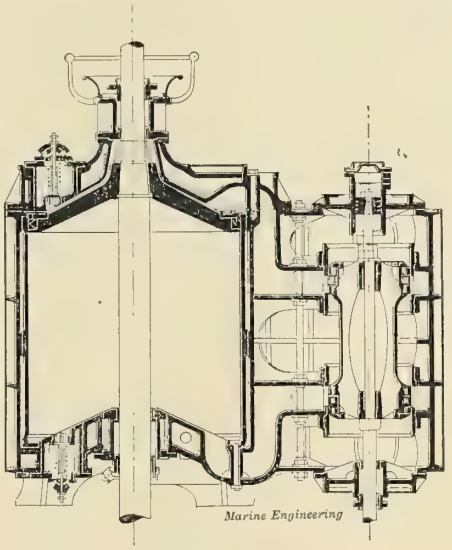


HIGH AND LOW PRESSURE CYLINDERS.

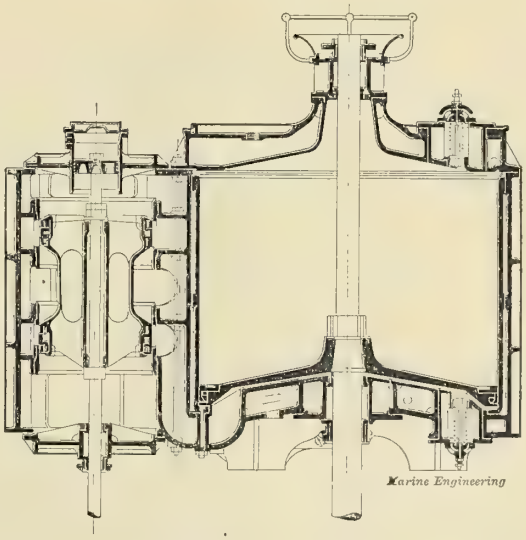
diameter of cylinder by 12 in. stroke and can be used as anchor windlasses in case of necessity. A horizontal engine of the same cylinder capacity is attached to each after warping windlass. The anchors are of the Hall's patent stockless variety made of wrought iron, two of which weigh 13,200 lb. each and two 11,000 lb. each. Furthermore there is one Trotman stream anchor weighing 4,600 lb., a kedge anchor of 2,300 lb. and the necessary sea anchor. The links of the main anchor chains are 3 1-16 in. diameter.

The cargo which the ship is intended to carry cannot be of great magnitude, as the ship is intended principally for passengers and mail; nevertheless five cargo winches have been installed as well as a small winch for stores. The winches are of the usual horizontal type, cylinders 7 in. diameter and 10 in. stroke, and can also be used for warping the ship. The small winch has cylinders 6 in. diameter by 10 in. stroke.

The steering gear of the *Deutschland* is of the Brown's steam tiller pattern, similar to that on the



FIRST INTERMEDIATE PRESSURE CYLINDER.



SECOND INTERMEDIATE PRESSURE CYLINDER.

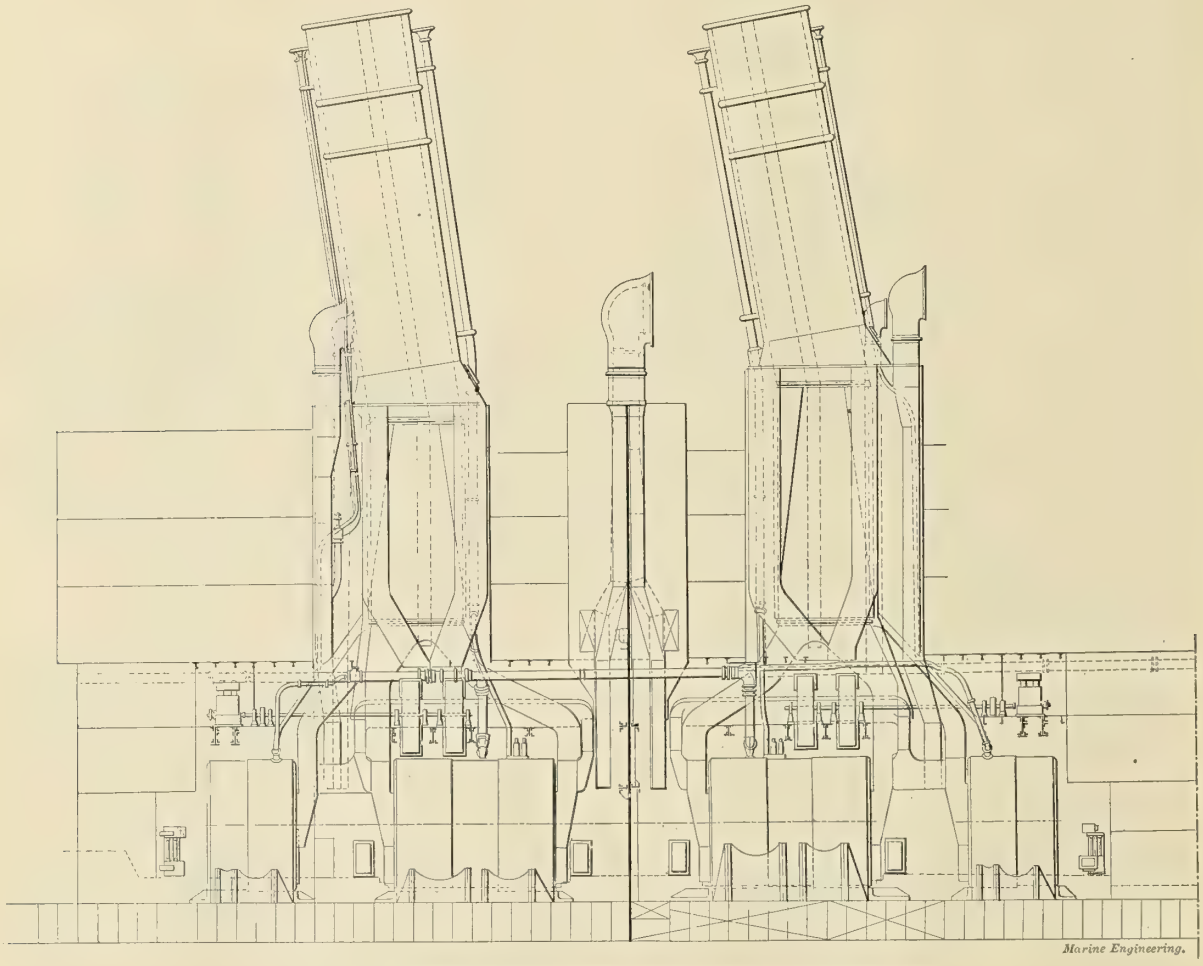
Kaiser Wilhelm der Grosse. It is located on the orlop deck aft. The 12 in. by 12 in. double cylinder engine is mounted on the tiller, which is not attached directly to the rudder stock, but is keyed to a cross head, which in turn is connected to a like cross head on the main rudder stock by means of connecting links. The engine on the tiller drives a vertical pinion by means of screw gear and wheel, and this pinion meshes into a toothed quadrant which is solidly fastened to the deck.

The operating gear of this outfit consists of the usual valve between the cylinders so arranged that

*Translated for MARINE ENGINEERING from *Zeitschrift des Vereines Deutscher Ingenieure*, November, 1900.

either side is a steam port or exhaust port. The steam and exhaust connections are attached to this movable gear by means of stuffing boxes with rotary sleeves. The auxiliary steam steering gear is also a horizontal double 12 in. by 12 in. engine and is located in an adjacent watertight compartment. It drives a horizontal shaft which passes through a stuffing box on the watertight bulkhead and drives the tiller by means of a sprocket chain and sprocket wheels. Both steering engines run in inclosed casings filled with oil.

The main condensers are placed on the outboard side of their respective engines. An auxiliary condenser with its circulating pump is located in the port engine room aft on the dividing bulkhead and opposite to this in the starboard engine room are the two evaporators and in the rear of the thrust bearing the salt water pump for the baths. The circulating pumps, air pumps, bilge pumps and sanitary pumps, one of each variety and one for each engine, are arranged symmetrically in both engine rooms. On the forward bulkhead of



AFTER BOILER ROOMS ON HAMBURG-AMERICAN LINE S.S. DEUTSCHLAND.

The operating valve on each engine can be actuated from four different positions on the ship; from the forward wheel house by means of the well known Brown's telemoter, from the wheel stand behind the compass on top of the wheel house by means of tell tales and shafting from the navigating bridge and also from a wheel stand located alongside the main steering engine itself.

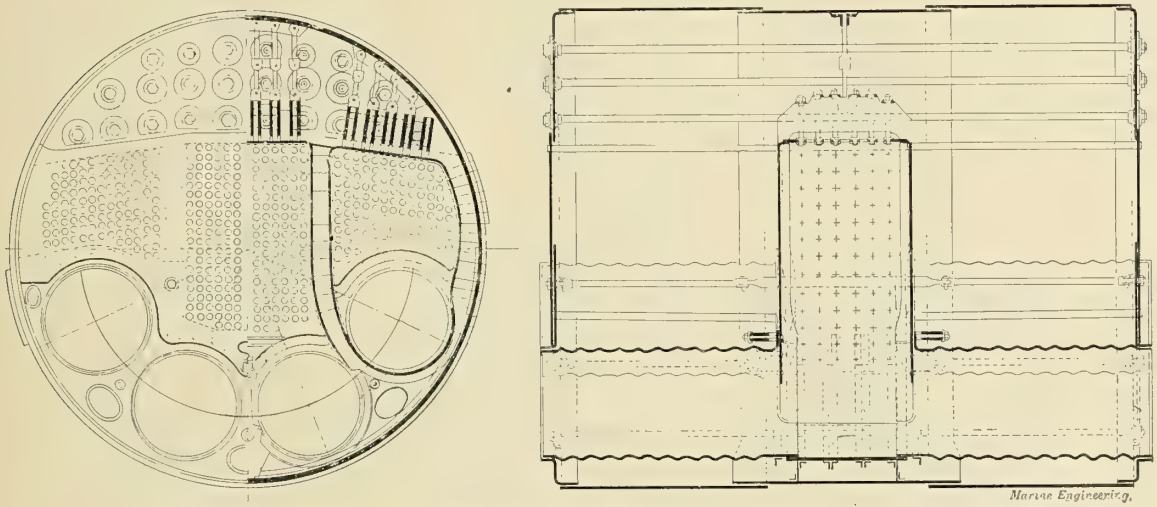
The main engines, balanced according to the well known Schlick system, with their necessary auxiliaries occuy the space from frames 55 to 90. The high pressure cylinders project above to within a short distance of the promenade deck. A fore and aft bulkhead divides the engine space into two watertight compartments, so that in case of necessity either engine can be worked entirely independent of the other.

each engine room are four Weir's main feed pumps and in the port engine room a donkey pump. Other fittings worthy of mention are the two drain tanks, two hot wells, two Railton and Campbell feed water filters and two Weir's feed water heaters. There is a total of seventeen auxiliary engines in each engine room.

In each engine room at the level of the promenade deck is a traveling crane of 18 tons capacity for lifting the cylinder covers, piston, etc. Aft of the engine space is the space for the electric and cooling plant, and aft of this a workshop for small repairs.

The four boiler rooms, which are inclosed by water tight bulkheads, extend from frame 90 to about frame 142, and from frame 158 to about frame 201. Between these are the coal bunkers. Each boiler room contains three double ended boilers and one single ended

boiler, the uptakes of which join into one smokestack of 13 ft. diameter and 105 ft. height above grates. The sixteen boilers have 112 furnaces and have a heating surface of 85,466 sq. ft. and grate surface of 2,188 sq. ft. The boiler pressure is 220 lb. Herewith is shown a double ended boiler, which is similar in design to the shell boiler, used almost exclusively in the merchant marine. With its diameter of 16 ft. 3 in. and the high steam pressure, the shell strakes must naturally be quite heavy. They are 1 15-32 in. thick, the heads 15-16 in. and the combustion chamber sides 23-32 in. The shell plates and butt straps have a tensile strength of 74,000 to 81,000 lb. per square inch with 20 per cent elongation in 7 7-8 in. Plates in contact with flame have a tensile strength of not over 60,000 lb. per square inch with 26 per cent elongation in 7 7-8 in. All other plates have a tensile strength between 57,000 and 71,000 lb. per square inch with 20 to 25 per cent of elongation. The steam space stays are screwed into the heads and are fitted with nuts and washers on both sides of the plates and the stay tubes are screwed into both tube sheets and beaded.



DOUBLE ENDED BOILER ON HAMBURG-AMERICAN S.S. DEUTSCHLAND.

All stay bolts are screwed and fitted with nuts and washers. All accessible seams are riveted hydraulically with steel rivets. The low water level is 52 in. above the center of the boiler. While each double ended boiler with its eight furnaces has 6,092 1-2 sq. ft. heating surface and 156 1-4 sq. ft. of grate surface, a single ended boiler with its four furnaces has 3,089 1-4 sq. ft. of heating surface and 78 1-8 sq. ft. of grate surface. The diameter of the single enders as well as the thickness of plates is the same as of the double enders and the length is about one-half. The proportion of heating surface to grate surface is 39 to 1 in the double enders and 39 1-2 to 1 in the single enders; their weight, empty, including lagging, is 216,000 lb. for the large and 130,000 lb. for the small boilers.

The blast for the Howden forced draft system is furnished by two blast fans in each boiler room, fitted with upright compound engines of 7 in. and 12 in. cylinder diameters by 7 in. stroke. The fan wheels are 20 in. wide at tips and 25 1-2 in. wide at inlet and have a diameter of 82 in. Each boiler room has a Blake auxiliary feed pump with 8 1-2 in. diameter water cylinders and 12 in. steam cylinders and 12 in. stroke; furthermore, the forward boiler room has a vertical duplex ballast pump with water cylinders of 11 in. diameter, steam cylinders of 11 7-8 in. diameter, stroke 11 7-8 in., with a capacity of 74,000 gallons per hour. The ashes are removed by means of hydraulic ash ejectors and also by means of small ash hoist winches, 2 3-8 in. diameter of cylinders and 7 7-8 in. stroke, which are located on the main deck. The feed water is pumped to the boilers by means of the four pairs of Weir's main feed pumps, located on the forward bulkheads of the engine rooms. These pumps have a steam cylinder diameter of 19 in., water cylinder diameter of 14 in., with 32 in. stroke. The pump deliveries are 6 7-8 in. diameter, and these combine into a main feed line of 9 in. diameter. The hot well suction pipes are 9 in. diameter and the main feed line as well as the auxiliary feed water line to each of the two boiler groups is 7 in. diameter.

Each of the two quadruple expansion main engines develops 16,500 horse power with 220 lb. of steam pressure and 76 revolutions. The main engine cylinders are arranged in a somewhat different manner than in the usual type of such machinery. The high pressures and low pressures are divided into two cylinders each and the high pressures placed above the low pressures tandem fashion, while the first and second intermediate cylinders are placed at each end. Between the groups are the rods which drive the valves of the high pressure cylinders. The high pressure and the two intermediate pressure cylinders of each engine have piston valves and the two low pressure cylinders are fitted with slide valves. The high pressure cylinders are 36 5-8 in. diameter; first intermediate, 74 1-4 in.; second intermediate, 103 15-16 in.; low pressure, 112 1-4 in. diameter, with a common stroke of 72 13-16 in. All cylinders have steam jackets, and the cylinder liners are of cast iron, 1 9-16 in. thick. When tested with hydraulic pressure the high pressure cylin-

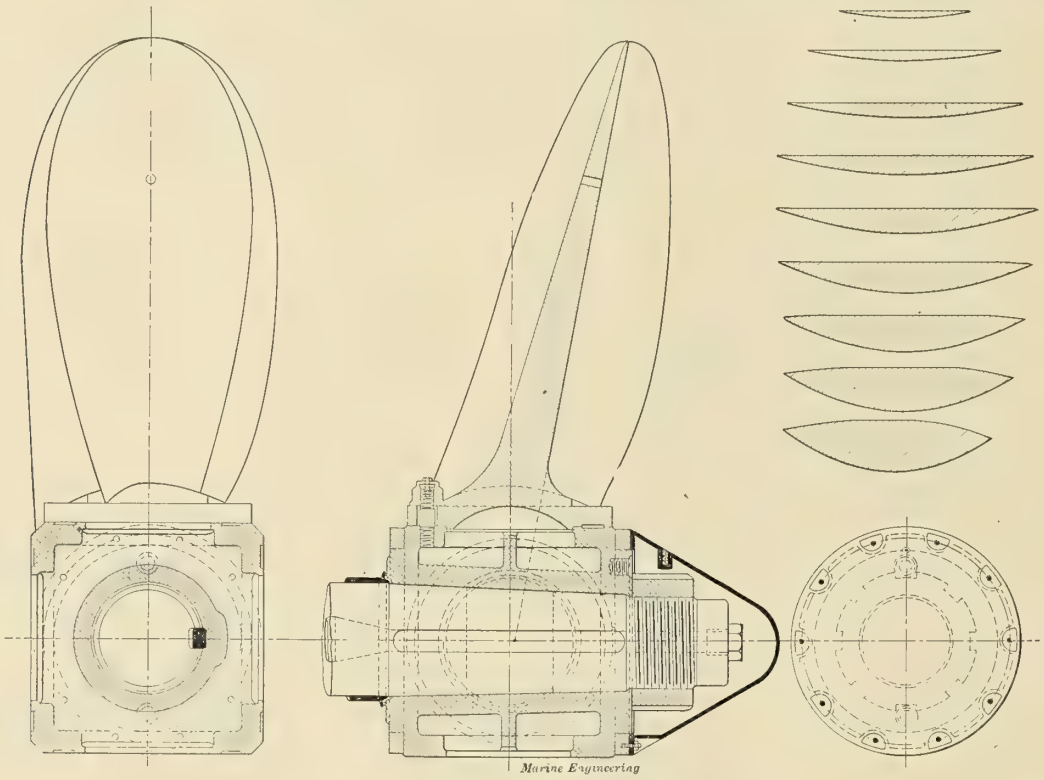
ders were subjected to a test pressure of 294 lb., the intermediate pressure cylinders, 191 lb. and 103 lb., and the low pressure cylinders, 44 lb.

The pistons are of cast steel and are of different thicknesses, so that the weights conform to the rules of the Schlick system. The low pressure pistons are packed with Peck's patent rings, the intermediate pressure pistons are fitted with Buckley's and the high pressure pistons are fitted with Ramsbottom rings. Every crosshead has four guide shoes, which are faced with white metal working on four cast iron guides, which are cored for circulation of cooling water. The hollow nickel steel crankshaft, which is built of four parts, has a tensile strength of 74,000 lb. per square inch and a limit of elasticity of 50,000 lb. per square inch. The

The weigh shafts are carried by bearings bolted to the main columns and operate the links in the usual manner with levers and drag links, and the levers are each fitted with the customary cut off adjustment.

In addition to the large reversing engine, each engine is fitted with an auxiliary reversing engine 7 in. diameter by 4 3-4 in. stroke connected to the weigh shaft with worm gear. An extension of the main bed plate adjoining the thrust contains the turning gear which consists of a double cylinder vertical engine 7 1-2 in. diameter and 8 in. stroke, connected to the worm wheel on the main engine shaft by means of the usual shifting worm shaft.

At the forward end of each main engine shaft are located a trunk bilge and trunk sanitary pump 8 in.



RIGHT HAND PROPELLER ON S.S. DEUTSCHLAND.

outer diameter of the shaft is 25 in. and the bore 10 in. Each shaft coupled up, weighs 223,500 lb.

The main bearing boxes are of cast iron with a white metal lining 7-8 in. thick. The main bearing caps are of wrought iron. Including the attached thrust foundation the bed plate of one engine is in eleven parts. The columns are of cast steel. The main engine throttle valves are of the double seat balanced variety with cast steel bodies, and each is worked from the operating platform by means of hand levers, as well as with a steam assistant cylinder of 10 1-4 in. diameter, fitted with a checking cylinder of 7 in. diameter and 10 in. stroke. One low pressure engine in each engine room has an Aspinall governor which is connected to its respective main throttle valve.

This vessel, as well as all of the large vessels built at the "Vulcan," is fitted with Brown's reversing engine. The steam cylinder is 25 1-2 in. diameter, checking cylinder 17 3-4 in. and stroke 24 in.

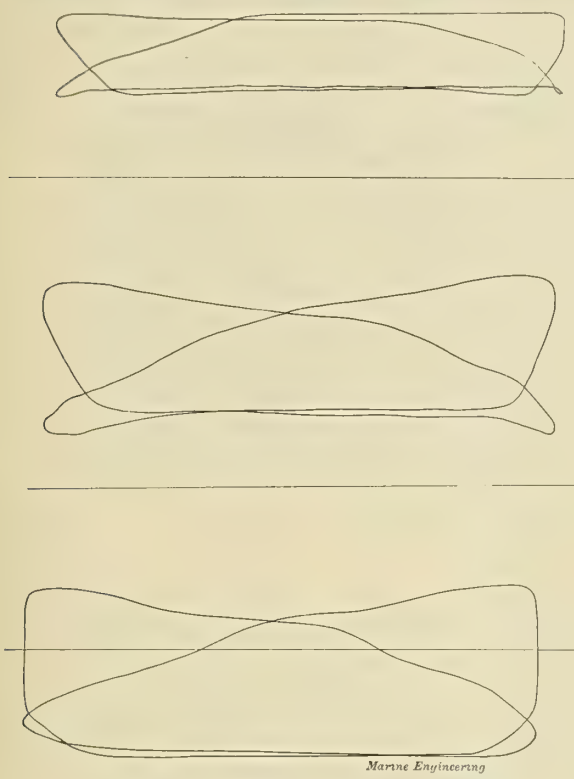
diameter of cylinders and 12 in. stroke driven by a pin at end of shaft. Each engine room has one Blake vertical twin air pump, air cylinders 44 in. diameter, steam cylinders 18 in. diameter by 24 in. stroke. Furthermore, each engine room has a 12 in. by 12 in. by 16 in. Blake vertical simplex bilge pump and a sanitary pump of the same size, each with a capacity of 440 gallons per minute. The bilge pumps take suction from the sea, from the bilges and from the ballast tanks and discharge over board and also to the deck washing lines. On the forward bulkhead of the port engine room is a 12 in. by 7 1-2 in. by 12 in. Blake vertical duplex donkey pump with a capacity of 440 gallons per minute. The main centrifugal circulating engines are of 12 in. stroke and make 150 revolutions per minute and the 4 ft. diameter impellers deliver each 17,650 gallons per minute.

Each condenser has 5,320 tubes 3-4 in. external diameter and 20 ft. 7 in. long with a total cooling surface

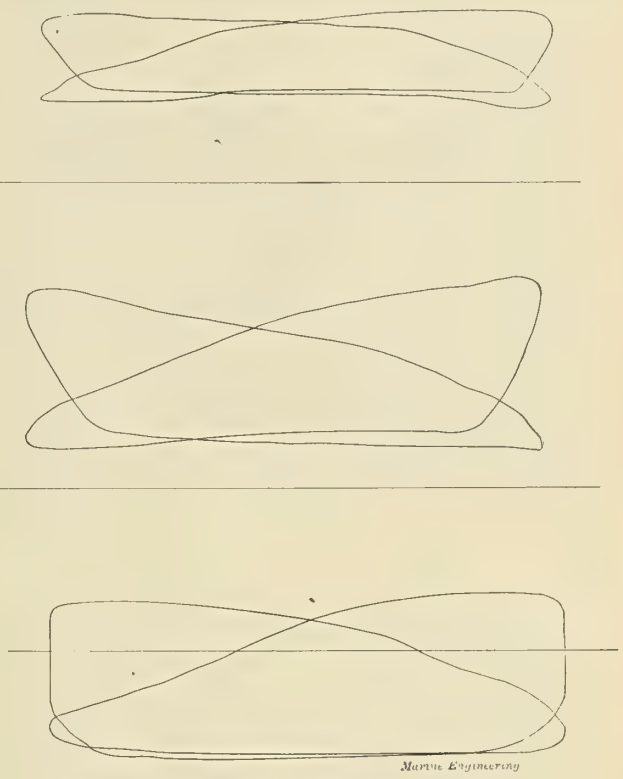
of 21,500 sq. ft. The shell plates and butt straps are of rolled brass, the tube plates of muntz metal and the tubes and stays of seamless drawn brass tinned inside and outside. The condensers, when finished, received a test pressure of 22 lb. per square inch. The feed water is taken from the condenser by the air pump and delivered to the hot well alongside the forward engine column and a Weir feed pump then passes it through a Railton & Campbell feed filter on its way to the Weir feed heater and is drawn from thence by another Weir pump, which delivers it to the main feed line. The make up feed water is furnished by two Morison evaporators with a capacity of 1,000 gallons per hour. The before mentioned auxiliary condenser is used for condensing the exhaust steam of all the auxiliaries when the main engines are not running. This condenser is 42 in. diameter, 6 ft. between tube plates, has 763 tubes with a cooling surface of 890 sq. ft. The centrifugal circulating engine to this condenser has a cylinder of 6 in. diameter and 6 in. stroke and the impeller wheel is 19 1-4 in. diameter. The suction and deliveries are 6 in. diameter and the capacity is 660 gallons per minute.

The warm salt water bath supply is delivered by a horizontal 6 in. by 4 in. by 6 in. Worthington pump located on the starboard after engine room bulkhead. This pump takes suction from the main condenser circulating discharge pipe and delivers to a tank fitted with a steam coil, located on the lower sun deck, and in which the water is heated to the proper temperature for the baths. From this tank supply pipes are led to the different bath tubs. The two horizontal 5 1-2 in. by 3 1-2 in. by 5 in. Worthington fresh water pumps draw from the fresh water tanks and deliver to tanks on the lower sun deck, from where the water is distributed by the usual piping. The tanks on deck are fitted with return overflows so that the pumps can work continuously even if they are filled.

Both of the Siemens-Martin steel thrust shafts are 25 in. diameter and each has twelve collars with 4,550 sq. in. of thrust surface. The tunnel shafting has diameter of 23 5-8 in., which is increased to 23 3-4 in. in the tunnel bearings. The nickel steel propeller shafts are 25 3-16 in. and 25 3-8 in. diameter and 40 ft. 2 in. long and the eleven pieces of shafting on each side have a total length of 216 1-2 ft. The propeller shafts are attached to the Siemens-Martin steel tunnel shafting by means of a heavy coupling. This coupling is shrunk on the propeller shaft and bolts to the enlarged coupling forged on the after tunnel shaft.



INDICATOR DIAGRAMS FROM PORT ENGINE.



INDICATOR DIAGRAMS FROM STARBOARD ENGINE.

The propellers are four bladed and the right hand wheel is shown on the opposite page. The blades are of bronze, hubs of cast steel and cones of cast iron. The flange studs are 4 in. in diameter. The diameter of the propellers is 22 ft. 4 in., pitch 36 ft. and the developed blade area of one wheel is 140 sq. ft. The thrust on the four blades of one wheel is 198,500 lb.

The *Deutschland* has been in steady service since July, 1900, and has fulfilled the expectations of her builders and owners in every respect. Following is a condensed abstract of her log on one of the best trips:

	Cherbourg to New York.	New York to Plymouth.
Time of passage, point to point	5 days, 12 hours, 29 min.	5 days, 7 hours, 48 min.
Average speed	23.02 knots.	23.36 knots.
Miles run each day	337, 566, 570, 570, 584, 423.	507, 535, 540, 549, 545, 396.
Coal consumption per 24 hrs.	561 tons.	572 tons.
Average revolution of engines	77 per min.	77.4 per min.
Average indicated H. P.	35988	36940

The indicator diagrams herewith given show the average performance at sea:

	Port. I. H. P.	Starboard I. H. P.
Crank I, 1st M. P.	4,000	4,119
Crank II, Ford H. P. & L. P.	4,820	4,695
Crank III, Aft. H. P. & L. P.	4,769	4,465
Crank IV, 2d M. P.	4,413	4,310
Total each engine	18,002	17,619
Total both engines		35,621

Coal for British Navy.—The cost of coal for England's navy during the year 1900 amounted to over $8,000,000.

Shipping Subsidies.—Shipbuilders and shipowners throughout Great Britain are agitating the subject of subsidies from their Government, to maintain their country's prestige on the high seas against European encroachment.

Parson's Turbines.—The topedo boat destroyer *Viper*, fitted with Parsons turbines, attained the phenominal speed of 36.58 knots on a recent trial. The four shafts, with two propellors each, averaged 1,800 revolutions per minute. Exhaustive trials are to be made of this boat during the summer.

Beeson's Marine Directory.—The fourteenth annual edition of Beeson's Marine Directory of the Northwestern Lakes for 1901, has been issued. Among the chief features are: Lists of American steam and sailing vessels on the lakes; lists of the owners of lake vessels; records of engines and boilers of lake vessels; lists of Canadian vessels on inland waters; lumber carriers, with capacities; vessels whose names have been changed; records of marine disasters on the lakes; ore docks; a classified trade directory of firms and companies connected with lake maritime industries. There are also a number of articles on subjects of lake interest. The volume is illustrated with many views of steamboats and steamships of all classes. The 264 pages are 6 1-2 in. by 9 1-2 in., printed on heavy paper and are strongly bound in cloth boards. The directory is published by Harvey C. Beeson, 308 Royal Insurance Building, Chicago, Ill., and is sold for $5.00 a copy.

Collision.—On June 14 the Staten Island ferryboat *Northfield* and the New Jersey Central ferryboat *Mauch Chunk* collided off the Battery, New York city. The tide flows very fast at this point and landings are made with difficulty. The *Mauch Chunk*, a steel screw boat, was coming into her slip which adjoins the Staten Island ferry when the *Northfield*, an old side wheeler, was leaving. The two boats collided, the *Mauch Chunk's* bow going under the starboard guard of the *Northfield*, tore her planking out above and below the water line. The steel boat backed out slightly injured, but the *Northfield* rapidly filled and sank near the shore. There were a thousand passengers on the *Northfield*, and most of them were rescued by jumping overboard and being picked up by tugs which came quickly to their assistance. Others clambered on shore, and four were drowned. The accident was evidently the result of rivalry between the two ferryboat captains, neither being willing to give way.

STEAMBOAT RACE ON LAKE ERIE.

A most interesting race between the side wheel steamboats *Tashmoo* and *City of Erie* was run on the calm waters of Lake Erie on June 4 over a course of 95 miles. These two vessels are of entirely different design: the *Tashmoo* is a shallow draft high speed passenger boat for river service, and the *City of Erie* is a freight and passenger boat of fuller lines and greater displacement.

The race had been previously arranged for and both vessels were in racing trim. The *Tashmoo's* engines are of the triple expansion, three crank, inclined type, with cylinders 33 in., 51 in., 82 in., dia. by 6 ft. stroke, while the *City of Erie* has a compound, vertical, jet condensing, beam engine built by the W. A. Fletcher Company. The high pressure cylinder is 52 in. dia. by 8 ft. stroke and the low pressure 80 in. dia. by 12 ft. stroke. A comparison of the two ships follows.

	Tashmoo.	*City of Erie.*
Length over all	315 ft. 0 in.	324 ft. 0 in.
Length load water line	301 ft. 0 in.	314 ft. 0 in.
Beam, molded	37 ft. 6 in.	44 ft. 0 in.
Beam, over guard	68 ft. 0 in.	77 ft. 2 1-2 in.
Depth molded at side	13 ft. 6 in.	18 ft. 0 in.
Crown of deck beams	4 in.	5 in.
Draft on race forward	8 ft. 1 1-2 in.	9 ft. 9 in.
Draft on race aft	8 ft. 5 1-2 in.	10 ft. 10 in.
Draft on race mean	8 ft. 3 1-2 in.	10 ft. 3 1-2 in.
Corresponding displacement	1,370 net tons	2,500 net tons.
Trial load	60 tons coal	250 tons coal and cargo
Dia. wheels	22 ft. 4 in.	28 ft. 6 in.
Face wheels	12 ft. 0 in.	12 ft. 0 in.
Boilers	2 D. E. Scotch 3 S. E. Scotch	6 S. E. Scotch
Dia.	11 ft. 1 in.	12 ft. 6 in.
Length	11 ft. and 22 ft.	11 ft. 9 in.
Working pressure	170 lb.	130 lb.
Grate surface	294 sq. ft	252 sq. ft.
Heating surface	8,750 sq. ft.	11,580 sq. ft.

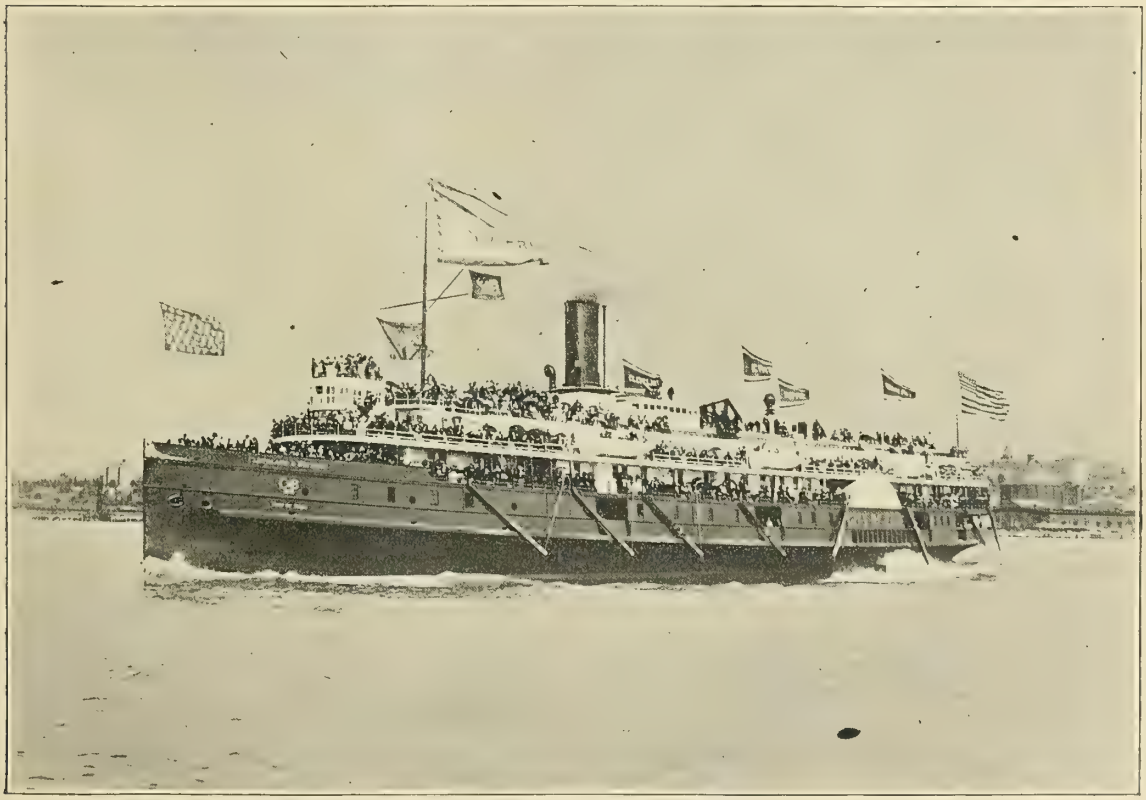
The boilers of the *Erie* are fitted with the Howden system of forced draft, and the *Tashmoo's* boilers burn at natural draft, assisted on the trial by steam jets. Both boats had all the steam they could use.

When the starting gun was fired both ships were lying motionless off Cleveland one-half mile from the starting point. The *Erie* was the first to cross the line, and the *Tashmoo* followed 35 sec. later. In the shoal water off Fairport the *Erie's* engines began pounding, and steam had to be temporarily throttled. She lost her lead, but regained it upon striking deep water and gradually drew ahead, finishing 1 min. 20 sec. before the *Tashmoo*. The amount by which the *Erie* won, correcting for the difference in time at which the vessels crossed the starting line was 45 sec.

The elapsed time of the *Erie* was 4 hr., 19 min., 9 sec., or at an average speed of 22.00 miles per hour. The average steam pressure was 118 lb.; maximum, 120 lb.; average revolutions of engine, 33.25; average horse power 6,450. The *Tashmoo* averaged 21.93 miles per hour at 40.08 revolutions with 170 lb. steam pressure and developed an average of 3,300 horse power. Reduced to long tons and knots, the admiralty coefficient of the performance of the *Tashmoo* is 236, and the *City of Erie* 184.

Both vessels were designed by Frank E. Kirby and built by the Detroit Ship Building Company.

EXCURSION STEAMBOAT TASHMOO OF THE WHITE STAR LINE.
(Copyright, 1900, by Detroit Photographic Co.)



STEAMBOAT CITY OF ERIE OF THE CLEVELAND AND BUFFALO TRANSIT CO.

STABILITY OF STEAMERS AFTER COLLISION AT SEA.*

BY M. BERTIN.

Continued from page 225.

Before beginning the study of the necessary additional bulkheading, it is advisable to first seek for all that can, without great modification, add to the efficiency of the present systems.

Transverse bulkheads are already as multiplied as the necessities of the service permit. In general, they are carried up as high as possible, it being known, however, that in the between decks they will be pierced by doors, usually open at the critical moment. We will suppose then that the transverse bulkheading of the vessel chosen for study is preserved without change. There remains for consideration the longitudinal and horizontal bulkheading. As regards the former we find the two bulkheads of the coal bunkers which isolate the boiler rooms from the skin of the ship, and which are prolonged when possible abreast of the engines in order to extend their protection to the entire propulsive machinery, both evaporative and motive. The protection of the propulsive machinery of the vessel with its compartments of large capacity has always attracted much attention from inventors. Likewise the measures of security proposed consist in general in the extension of the double bottoms and the establishment of a more developed system of lateral bulkheads. I will cite as an example a proposition of M. Duchesne to the Society of Civil Engineers at a session at which I was present. From what has been seen above measures of this kind may increase the dangers, viewed from the standpoint of stability, and they require therefore a careful preliminary study. The filling of an outer compartment on one side of the ship produces in fact an initial inclination the pernicious effect of which is shown by a comparison of Tables III and IV.†

When a central compartment such as *A*, Fig. 3, is protected by watertight bunkers such as *B B'*, it is advisable, in order to balance the introduction of water on the two sides, to make a communication between *B* and *B'* by pipes traversing *A*. Two pipes are necessary for this purpose, one for the passage of water at *T* but above the pile of coal dust at the bottom of the bunker, the other for the passage of air at *T'*. We shall assume henceforth the two pipes *T* and *T'* fitted on the ship which we are studying. In order to avoid an error which I have seen committed through oversight, I will say that the pipes *T* and *T'* have no other effect than that of preventing heeling of the ship, and that they have no direct action on the initial stability. Thus between the two compartments *D* and *D'* the filling of which would only introduce a small amount of water on board the ship, but which would sensibly modify the contour of the water plane, communicating pipes would be of no utility.

The inclination resulting from the unsymmetrical invasion of the hull would be particularly dangerous if we consider a twin screw ship having in the damaged part a single central longitudinal bulkhead without lateral compartments *B B'*. The experiment with the model has not been made under these conditions, but it is not doubtful that with a whole side of the hull filled, in the place of the single compartment *B*, the other conditions being the same as those seen before in Table IV, the ship would be lost. On twin screw passenger steamers the two engine rooms being advisably separated one from the other, the piping *T T'* should place each of them in communication with lateral compartments arranged for this purpose, the more frequently forward or aft of the engine rooms.

If now we pass to the study of the horizontal bulkheading, we see that it suffices to enclose the hatchways of the lower deck with watertight trunks extending over the height of the second between deck, in order to have a complete bulkhead separating the upper parts of the ship from the lower. The value of the horizontal watertight bulkhead is specially manifest when the damages are limited to one of the two regions which it separates. A ship which has torn upon a rock the skin of a large compartment or of several transverse compartments, is exposed to the danger either of remaining fast on the rock held by its own weight, or to sink

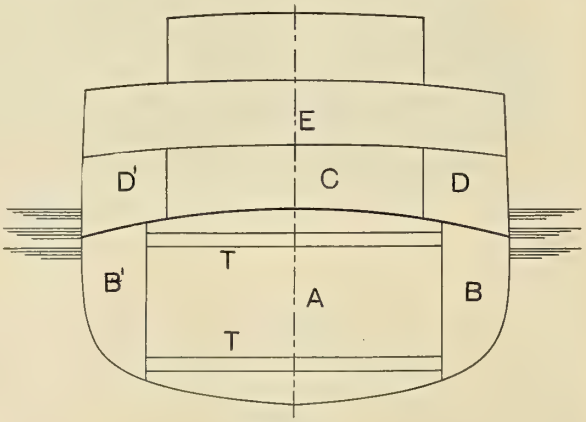


FIG. 3.

after having cleared the rock. The horizontal bulkhead safeguarding here the buoyancy which is more menaced than the stability will provide safety against this double danger. A passenger steamer struck by a sailing vessel with projecting stem and opened in her upper works only, is completely safeguarded by this means from the invasion of water into the engine or boiler rooms, and thus all her means of propulsion are preserved.

We shall suppose in all which follows that the deck situated over the hold is disposed, in such manner as to form a horizontal watertight protection as a second measure of precaution, adding itself to that given by the longitudinal bulkheads. It will be further noted that the collection of horizontal and longitudinal bulkheads isolates the large compartments *A* of the hold at the same time from the lateral bunkers *B* and from the between deck *C*, in such manner that *A* is completely protected from the water in case of collision, whatever may be the size of the openings. The efficiency of horizontal bulkheading may be increased by the adoption of a rounded form somewhat like that used for the protective deck of cruisers.

In case of damage to the hull, the volume of water introduced into the two lateral bunkers *B B'* and, in

*A paper read at the Congress of Naval Architects, Paris, 1900.

†See Marine Engineering for June, pp. 224 and 225.

consequence, the added immersion of the ship are diminished, and, what is most important, in case of collision opening the skin of the upper works, the chances are increased that the breach will not extend to the region of the hold, and that the two compartments B B' will remain protected from the invasion of the water.

proximately, at least, to the case where the damage annuls the effect of the new subdivision remaining to be considered.

The means of completing the protection of the stability against the destructive effect of breaches at the belt, has been naturally suggested by the solution adopted on

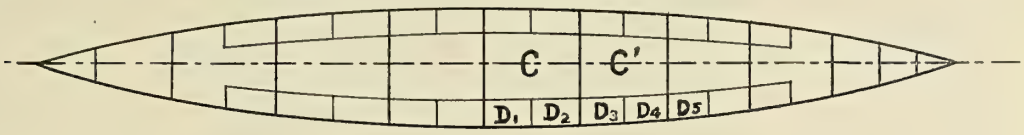


FIG. 4.

TABLE VI —D_1, D_2, D_3, D_4, D_5 open to water.

	Full load.	Half load.	Light.
i. Initial inclination for equilibrium	8 1-2°	16 1-2°	The steamer is in unstable equilibrium.
$\rho_i - a$. Initial metacentric height	1.90 ft.	.56 ft.	
$(\rho_m - a) \sin \theta_m$. Maximum stability arm	1.25 ft.	.16 ft	
θ_m. Inclination corresponding to this maximum	16 1-2°	10 1-2°	
θ. Angle of vanishing stability	30 1-2°	19 1-2°	
ϕ. Angle of dynamic stability	8 1-2°	5 1-2°	
ϕ_1. Same angle referred to ship intact	7°	4 1-2°	

TABLE VII.—D_1, D_3, D_5 open to water.

	Full load.	Half load.	Light.
i. Initial inclination for equilibrium	4 1-2°	13 1-2°	25°
$\rho_i - a$. Initial metacentric height	2.3 ft.	.76 ft.	1.28 ft.
$(\rho_m - a) \sin \theta_m$. Maximum stability arm	.72 ft.	.53 ft.	.07 ft.
θ_m. Inclination corresponding to this maximum	21°	24 1-2°	4 1-2°
θ Angle of vanishing statical stability	41°	33 1-2°	8 1-2°
ϕ. Angle of dynamic stability	11°	14 1-2°	2 1-2°
ϕ_1. Same angle referred to ship intact	10°	11 1-2°	2°

TABLE VIII.—D, open to water.

	Full load	Half load.	Light.
i. Initial inclination for equilibrium	1°	1-2°	11 1-2°
$\rho_i - a$. Initial metacentric height	2.79 ft.	1.54 ft.	1.35 ft.
$(\rho_m - a) \sin \theta_m$. Maximum stability arm	1.05 ft.	.89 ft.	.46 ft.
θ_m. Inclination corresponding to this maximum.	24	28 1-2°	19°
θ. Angle of vanishing stability	49 1-2°	44°	30°
ϕ. Angle of dynamic stability	13°	17°	11°
ϕ_1. Same angle referred to ship intact	13°	15 1-2°	12 1-2°

In all the experiments with the model, with the adoption of the measures for preserving the stability, the protecting deck has the form represented in Fig. 3.

Although the conditions of stability may be greatly improved by the preceding modifications, the danger of capsizing is not yet removed. It is then useless for us to stop at the model experiments corresponding to these conditions. We will suppose then that the vessel has received the additional protection necessary in order to give the demanded guarantees. The model being ready, the experiments made under these conditions extend approximately, at least, to the case where the damage annuls the effect of the new subdivision remaining to be considered.

The means of completing the protection of the stability against the destructive effect of breaches at the belt, has been naturally suggested by the solution adopted on warships in analogous conditions. It consists in suitably bulkheading the between deck situated at the level of the water line. As the breaches to be feared are less numerous and much less profound, the problem of protection is infinitely more simple, therefore, than for warships, thus making possible all needful arrangements relating to securing the cargo or the lodgment of passengers. The detachable blocks of the experimental model are represented by Fig. 4. It supposes only the addition in the second between deck, of two bulkheads at 9.84 ft. distance from the skin for the greater part

of the length of the steamer, with small transverse bulkheads dividing equally in two each of the lateral compartments thus formed.

There were, in the model, five blocks, D_1, D_2, D_3, D_4, D_5, which were withdrawn successively, but for greater simplicity we will limit ourselves to the results obtained with one, three, or five blocks. In order to class the results of these means in the order of efficiency, the same as we classed above the damages in order of gravity, we will suppose first five compartments opened, then three, then a single one, in each series of experiments.

The supposition of more than two lateral compartments opened to the sea is only applicable to the very rare case of collision followed by prolonged contact; it has been, however, adopted in view of giving greater generality to the study. Furthermore, we have not taken into account the displacement of the materials in D, although this displacement reaches a very notable fraction of the capacity if compartment D is made a store room for baggage and merchandise, as we suppose.

The effect of the means of preservation adopted is then certainly larger than our hypothesis supposes, and the stability of the ship itself will be superior, with damage, to that which the experiments indicate.

There are two series of experiments, the one with the invasion by water of the two compartments B and B', Fig. 3, the second in supposing the effect of the breaches limited to the second between deck. In operating for the three conditions of lading, there were, in the two series, thirty experiments of which eighteen only figure in the Tables following.

Let us take first the case where the lateral store rooms of the hull B and B' are full of water.

Under the conditions of Table VI, the vessel is lost. It is wholly, or, at least, seriously compromised, even in the state of half load. It was easy to foresee this result, since the effect of the new bulkheads is almost entirely destroyed by these damages, extending as they do through three large transverse sections of the vessel in the second between deck, while they involved only two in Table V. The experiments leading to Table VI were made with the purpose of extending the results obtained beyond the cases of probable damage.

Under the conditions of Table VII, the security, well guaranteed with half load, is not so for light condition. The situation of the boat is, however, in all conditions very much bettered in comparison with that of Table V. It may be further noted that Table VII supposes three breaches, while Table V supposes only two. Further, as the compartments D should be in reality filled with bulky objects, of which the experiment took no account, the effect of such breaches, involving two or even three compartments, D_1, D_2, D_3, is represented in reality by Table VIII; the displacement of packages well stowed easily rises to two-thirds of the capacity, the imbibition of the freight is negligible.

In the conditions of Table VIII, which will be practically those of the passenger steamer before damage, even when a transverse bulkhead would have been torn in D, security can be regarded as assured in all conditions of loading. At the most, the working of the ship in light condition requires still a certain prudence.

The situation is very notably bettered, if we suppose that the lowering of the protective deck outboard would have produced the effect sought for, that is to say, that the breaches would stop above this deck. The two between decks C and E are then only invaded, the lateral store rooms B and B' remaining watertight.

Steamship Haverford of the Red Star Line.

The Red Star Line will soon have two new sister ships, the *Haverford* and *Merion*, running on the Philadelphia route. The *Haverford*, which is here illustrated, was recently launched from the yard of John Brown & Co., Ltd., Clydebank, Scotland. She is of the intermediate type for carrying first and third cabin passengers, and a large cargo, at a speed of 17 knots.

Her principal dimensions are:

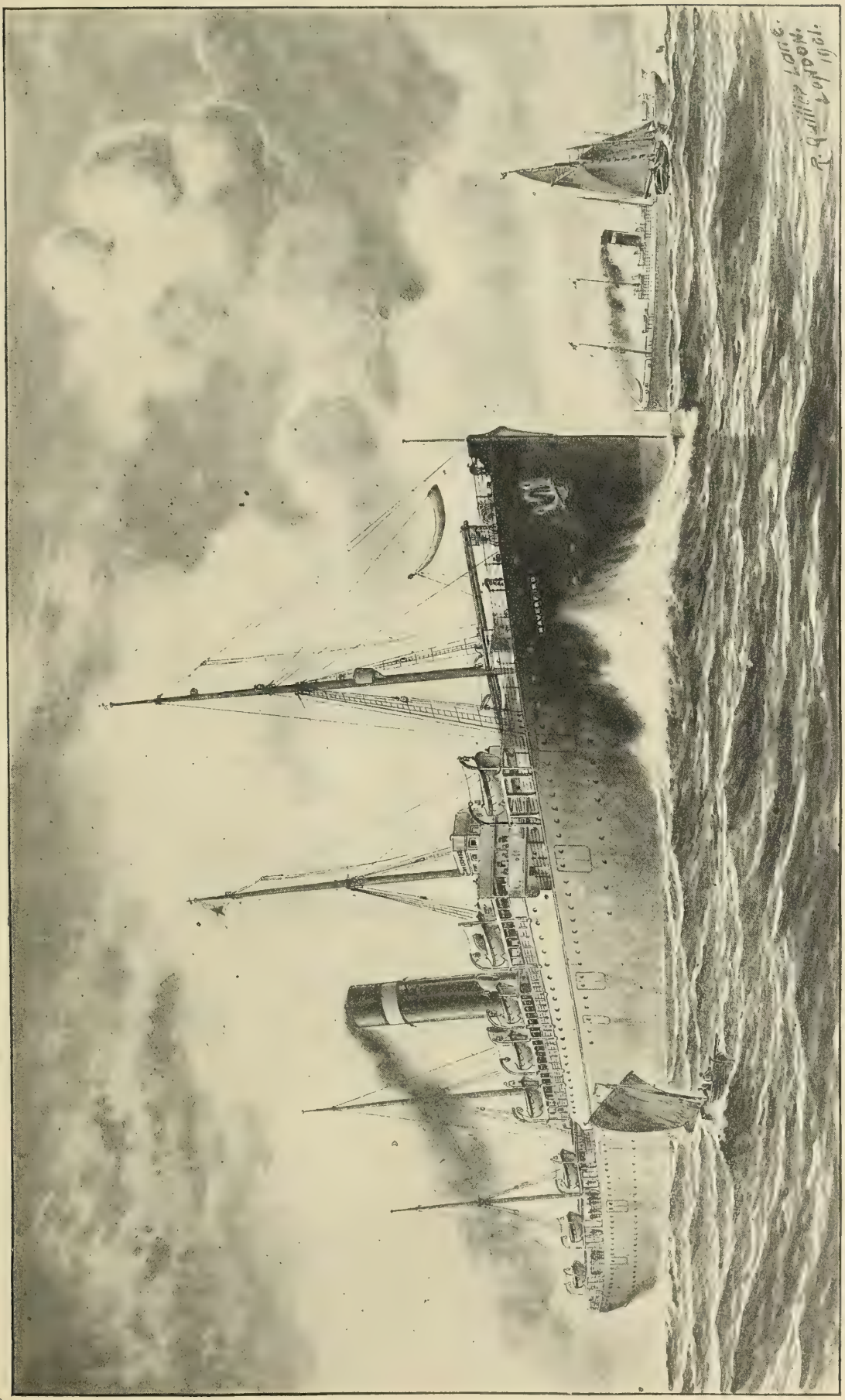
Length between perpendiculars	530 ft.
Breadth	59 ft.
Depth, molded	39 ft.
Gross tonnage	11,500 tons.

The ship has a fore and aft rig with four masts and ten derricks. There are seven hatches, and the ten winches as well as the windlasses are of American build.

Cabins for both classes of passengers are located amidships. In a large deck house on the upper deck are accommodations for 500 third class passengers, including dining room, lavatories, and a smoking room. In the bridge house 150 first cabin passengers can be accommodated. At the forward end is a handsomely furnished dining room with seats for 112 persons, and aft this are the large state rooms, bath rooms, pantry, etc. On the promenade deck above are the ladies' boudoir, smoking room, library and officers' quarters.

The propelling machinery consists of two sets of vertical triple expansion engines, with cylinders 29 in., 46 1-2 in. and 75 in. dia., with stroke 4 ft. 3 in. To each set of engines is fitted adirect acting steam reversing engine, and the levers of the reversing shaft are fitted with screw gear to admit of the adjustment of cut off being made in one cylinder independently of any of the other cylinders. The high pressure cylinders are fitted with piston valves and the others with slide valves, all driven by Stephenson links. The air pumps are direct connected and are driven by levers from the intermediate crossheads. Steam is supplied at 160 lb. pressure by two single ended and two double ended boilers. All the cylinders, liners, covers, front and back columns, condensers, and sole plates are of cast iron, and the condensers form part of the main engine framing. All the shafting is of steel, and each crank shaft is of the built up type in three interchangeable pieces. The propellers are four bladed, with bosses of cast iron and blades of manganese bronze.

Submarine Boats.—A new submarine boat has been built in Stockholm by L. E. Enroth, and offered to the Swedish Admiralty. She is fitted with twin screw engines, and two boilers for service while above water. When submerged, the engines are run by compressed air stored in receivers. The boat is 84 ft. long, 13 ft. 1 1-2 in. beam and 11 ft. 6 in. deep and cost about $80,000. A speed of 6 knots is attained under water.



STEAMSHIP HAVERFORD OF THE RED STAR LINE.

ON THE USE OF LIQUID FUEL IN SEA GOING MERCHANT STEAMERS.*

BY E. L. ORDE.

It is only within the last few years that liquid fuel has come within the province of engineers in this country, owing to the fact that hitherto it has only been practically obtainable in the vicinity of the Caspian Sea at such a price as renders it commercially possible. Within the last few years, however, a considerable change has taken place. New oil fields have been discovered, and the number of places along the Eastern route at which liquid fuel can be obtained has increased so enormously that it becomes a serious question for shipowners to consider whether it is not an absolute economy to use it in preference to coal on vessels trading to the Eastward. The solution of this question lies first in the cost of the fuel and its practical calorific value as compared with coal; secondly, in its effect on the life of the boiler furnaces in which it is burnt; and thirdly, perhaps the most important of all, its immunity from danger. The first point is, of course, constantly varying, and is one which the writer is not in a position to pursue. The two latter practically resolve themselves into one—the efficient combustion of the fuel. The existing appliances designed for the purpose may be broadly divided into three.

First. Those in which the liquid fuel is injected into the furnace in the form of a spray by purely mechanical means.

Second. Those in which the spray is produced by the introduction of a gaseous medium.

Third. Where the liquid fuel is introduced into the furnace in the form of vapor.

Before considering the respective merits of these three classes of apparatus, it will be advantageous to realize the actual possibilities of the fuel. The experiments which the writer carried out were made with crude Borneo oil, which is in all respects an excellent fuel oil, and is to be obtained in large quantities. Its composition is:

Carbon	87.9	per cent.
Hydrogen	10.78	"
Oxygen	1 24	"

The flash point is 211 deg. F.; the boiling point is 395 deg. F. The calorific value determined by the Bomb calorimeter is 18,831 B. T. U. It is an exceptionally clean and mobile fuel oil, and with its high flash point the risk of adventitious explosion is reduced to a minimum. All fuel oils are exceedingly complex, inasmuch as they are made up of a number of combinations of carbon and hydrogen which only a chemist who has devoted himself to investigating hydrocarbons can appreciate at their true significance. The importance of this point for the practical purposes of the engineer lies in the fact that the various constituents of the fuel give off vapor at temperatures varying from about 100 deg. F., up to the boiling point of the oil. When the boiling point is approached —unless special precautions are taken—a residue of solid carbon is formed which will soon choke any pipes or narrow passages through which the fuel may have to pass. Having thus considered the characteristics of a typical fuel oil, we may now return to the consideration of the apparatus for burning it.

In the first type, the purely mechanical spray, the oil is discharged under pressure into what is commonly called a burner, which is made of such a form that the effluent jet is broken up into particles sufficiently small to burn readily at the firing point of the fuel. The full efficiency of the system can only be obtained by lining the furnace with fire bricks, or other non-conducting material, so as to raise the furnace temperature (by preventing the absorption of heat into the boiler) until it is sufficiently high to vaporize the greater portion of the oil before it is burned. The quantity of air required to complete combustion is very largely in excess of what is chemically necessary, and the furnace space required for oxidation is large. The advantages of the system are: First, its simplicity; and, secondly, its noiselessness.

As regards efficiency, the best results that the writer has been able to find recorded show an evaporative efficiency of about 12.5 lb. of water from and at 212 deg. per lb. of oil. With Borneo oil this gives a fuel efficiency of 64.6 per cent.

In the second class the oil is introduced into the furnace in the form of a spray in the presence of a gaseous medium—be it steam or air. In most of these appliances a partial lining of fire brick is fitted in the furnace, and a brick bridge or baffles of various forms are built with a view of obtaining complete oxidation of the fuel. The earliest form of this apparatus consisted simply of two pipes lying one above the other, and having their ends flattened so as to spread the streams of oil and steam. Oil is admitted to the upper pipe and is allowed to drop from the orifice into the jet of steam which passes through the lower pipe and meeting the oil breaks it up into particles sufficiently small to ignite as soon as the firing point is reached. This simple device has been improved upon by numbers of engineers, and most of the improved burners of this type take the form of concentric tubes, through which the oil and steam are passed. Adjusting arrangements are always provided, so that the supply of the two elements can be regulated at will. This type is better known than any other, and has, so far, given the best results. The evaporative efficiency of the best burners of this type seems to be about 13 to 14 lb. from and at 212 deg., but the supply of air required for oxidation though smaller than that demanded by the first class of burner is much above what is chemically necessary. The difference between steam and air as spraying media will be touched upon hereafter. The third class of apparatus, that is, in which the fuel oil is wholly or partially vaporized, promises to give the best results.

Attempts have been made so long ago as 1867 to produce an apparatus on the system, and Colonel Foote claimed remarkable results for his method of solving the problem; these results, however, seem not to be well authenticated. Later, Messrs. Dorsett and Blyth attempted to boil the fuel in one boiler and burn the resultant vapor in the furnace of another. This, however, does not seem to have been very successful. Mr. Thwaite has since then made an apparatus consisting of a retort which is maintained at a red heat, and

*From a paper read before the North-East Coast Institution of Engineers and Shipbuilders, at Sunderland, England.

into the retort a spray of steam and oil is blown; the oil is immediately volatilized and passes through holes in the retort into the furnace, where it is met by a stream of air in which the vapor burns with a clear blue flame. The results are said to be satisfactory, but it is difficult to see how such a process can be carried out with ordinary fuel oils without producing a large deposit of carbon in some form in the retort.

An experiment tried by the writer with an apparatus on this principle showed that it was possible to produce a high furnace temperature and a smokeless fire, but the retort was soon completely choked with solid carbon, or, if the temperature was allowed to fall, with a pitch-like substance. This deposit presents the greatest difficulty in the way of completely vaporizing so complex a body as the ordinary fuel oil. As has been pointed out before, the oil consists of a number of hydrocarbon combinations, each of which has a different boiling point.

Another important characteristic of these hydrocarbon compounds is that in the presence of superheated steam, they can be completely distilled without cracking, and the explanation of this fact (on which depends the Ragosine process for refining petroleum) has been stated to be that in the presence of superheated steam, the boiling point, or more correctly, the mean boiling point, of the oil is lowered. This distillation, however, does not apparently take place with any other medium but steam.

To insure distillation it is necessary that the temperature of the oil should be raised to as near the boiling point as possible before it is admitted into the presence of the steam, and it is in this part of the process that the danger of cracking appears. In the apparatus fitted by the firm with which the writer is connected the difficulty has been overcome, and so far as it has been possible to ascertain by ordinary means, complete vaporization has been secured. The vapor thus produced can be completely oxidized by the amount of air chemically necessary, and a larger quantity of oil can therefore be treated in the same furnace space than by either of the two other systems, while the combustion as shown by the analysis of the waste gases is complete.

Two typical analyses are given below:

Analysis of Waste Gases.	Per cent.	Analysis of Waste Gases.	Per cent.
Carbon dioxide	13.2	Carbon dioxide	12.6
Oxygen	3.6	Oxygen	4.0
Carbon monoxide	0.0	Carbon monoxide	0.0
Hpdrocarbon gases	0 0	Olefines, etc	0.0
Hydrogen	0.0	Hydrogen	0.0
Nitrogen	83.2	Nitrogen	83 4
	100.0		100 0

The only feature calling for remark is the somewhat large percentage of uncombined oxygen, which is no doubt due to leakage around the smokebox. As regards efficiency an evaporation of from 15 to 16 lb. from and at 212 deg. should always be obtained with dry Borneo oil.

The hydrocarbon vapor is exceedingly unstable and appears to depend for its existence entirely on temperature. Efforts have been made to collect samples for analysis, but without success. In appearance it is of almost milky whiteness, closely resembling the vapor given off from the retort used in the Pintsch gas system. The smell is pungent, and severe irritation is set up in the membranes of the mouth and throat if the vapor is inhaled.

At the temperature of the external air (60 deg.) it was found almost impossible to ignite it, and the outer surface of the jet was at once condensed and formed an oil deposit of a very much lighter color than the fuel oil itself.

The flame when the vapor is burned in a boiler furnace over a layer of broken fire brick is of dazzling whiteness and becomes almost transparent as it approaches the bridge.

The exact form in which the combustion of these hydrocarbon vapors takes place does not seem to be clearly understood.

The appearance of the flame at a distance of a few inches from the nozzle of the burner suggests that at that point the hydrocarbons are burning in the form of acetylene.

All gaseous hydrocarbons when exposed to a temperature of 1,000 deg. F. become acetylene, and it seems fair to assume that the vapor will do the same. As the flame proceeds further into the furnace, however, and the temperature becomes higher, the hydrocarbon combination must break up and the rest of the vapor is probably burned as carbon monoxide and hydrogen.

This theory is put forward with diffidence in the hope that the reaction which takes place may be more worthily dealt with in discussion.

There seems to be no doubt that the efficiency of liquid fuel lies in the fact that it is capable of being turned into vapors of high calorific power, and that the vaporizing process does not demand a large heat expenditure.

The two classes of apparatus first described do not vaporize the fuel before combustion begins, which means that of the heat generated in the furnace some considerable part is absorbed for this purpose, and is therefore not available for evaporating water. To attain to the temperatures required for complete vaporization, part, at all events, of the constituents must be exposed to the heat of the furnace, but with careful design the quantity of heat thus abstracted can be reduced considerably below that which is necessary to carry out the process when the fuel is simply injected into the furnace as spray. The fact that superheated steam lowers the boiling point of hydrocarbon oils, and therefore prevents cracking, renders its employment essential if it is desired to burn the fuel as vapor. The objection to using it on board ship is, of course, the loss of fresh water and the amount of heat lost in making this loss good by distilling sea water; this loss, however, is, the writer ventures to think, more than compensated by the gain in efficiency due to using steam as a distilling agent. Mr. Morison has published some calculations of the quantity of fuel required for distilling purposes, and applying these calculations to a steamer with engines indicating 2,000 H. P. at sea, the quantity of oil fuel required to make up in the evaporator the water lost in the burners only amounts to one-quarter of a ton per day of 24 hours. In this

calculation Mr. Morison's calculated result has been multiplied by *four* to allow for deposit on the surface of the evaporating coils.

With air as a spraying agent, there is, of course, no loss of fresh water, but it is questionable whether the quantity of steam used in the air compressors is not greater than that required in the burners and evaporators together. The complete combustion of petroleum spray depends firstly on the correct relation between the volumes of the oil and the spraying agent, and, secondly, on the velocity of the spraying agent, both of which requirements place air at a considerable disadvantage as compared with the steam. The general conclusions produced from the investigations the writer has made are as follows:

(1) Liquid fuel of good quality, such, for instance, as Borneo oil, used in boiler furnaces, if efficiently treated, should show a reduction in consumption of about 40 per cent as compared with coal.

(2) A reduction in bunker space of about 15 per cent for the same weight of fuel; a reduction of about 50 per cent for the same radius of action.

(3) A reduction in the stokehold staff of at least 50 per cent.

The advantages of liquid fuel as regards ease of manipulation, cleanliness, absence of smoke, reduced temperature of stokehold as compared with coal, increased life of boilers owing to constant temperature, improved performance of engines owing to constant steam pressure, need not be enlarged upon, but the question of immunity from danger requires some consideration. With a fuel oil of which the flash point is 200 deg. F. or over, there should be no risk of explosion whatever, and, unless there is want of ordinary care in the management of the burning apparatus and the fuel supply, the danger of fire ought not to exist. Still, fires have occurred, and it may be well to consider the causes from which they have originated.

The most fruitful cause appears to be intermittent action of the burning apparatus. This may arise from dirt in the oil or from the presence of water. To get rid of the dirt it is only necessary to provide an efficient filtering apparatus, and this should form a part of all liquid fuel installations. The second cause, the presence of water, presents a more difficult problem. All crude oils have a certain proportion of water intimately mixed with them, and as the specific gravity of most fuel oils is from .9 to .98, and in the case of some shale oils even higher, it is obviously exceedingly difficult to eliminate this water by gravitation unless the temperature of the mixture is comparatively high. The expansion of oil under increase of temperature is considerably greater than that of water, and some arrangement whereby heat can be applied to the contents of the bunker seems to be necessary where crude oil is used.

In furnaces where the oil fuel is burned in the form of vapor, the danger of extinction from the fact that water is present is, of course, considerably reduced, for any temperature that is sufficiently high to vaporize a fuel is more than sufficiently high to evaporate water, so that when water passes into the apparatus with the oil it flashes into steam, and though it breaks up the stream of hydrocarbon vapor does not prevent each fraction from burning unless the amount of water is abnormally large.

An experiment made by the writer showed that the fire was not extinguished when water was present in the proportion of five parts of water to three of oil. The water in that case was added gradually and the contents of the bunker were constantly stirred so as to secure as complete an admixture of the oil and water as possible.

With a burning apparatus of the second type where the oil fuel is introduced in the form of spray, the danger of extinguishing the fire when water is present is, of course, much greater, but with a well designed installation and proper care on the part of the attendants such accidents as fires should be impossible.

S.S. Port Royal and Port Antonio.

The commerce of the Island of Jamaica has fallen off within the last few years to such an alarming extent, that the British Government decided that some legislative action was necessary, and thereupon Parliament voted an annual subsidy of $200,000 to the company who would establish a line of fast mail steamers between this island and Bristol, England.

The Elder, Dempster & Co. secured the contract for this service, and at once ordered two specially designed fifteen knot, twin screw steamers of Dixon & Co. shipbuilders at Middlesbrough.

With this means of quick communication from the fertile island to the English markets, it is expected that the fruit trade of Jamaica will be greatly developed.

The two ships are named *Port Royal* and *Port Antonio*, the first is already on the line and the second will soon be completed. They have accommodations for carrying the mails, 100 first cabin and 50 second cabin passengers, and a large part of the cargo space is lined and insulated for cold storage for carrying fruit.

The steamers are of the following dimensions: Length between perpendiculars, 382 ft.; beam, 46 ft. 6 in.; moulded depth, 32 ft. 7 1-2 in. The passenger accommodations, located in deck houses amidship, are very luxurious. Large ports and hatchways are provided, with improved winches for rapidly loading and discharging the cargo.

The accompanying illustration, reproduced from *The Engineer*, shows the port engine looking forward. Though somewhat heavy, it is of improved design. The cylinders are 24 in., 38 in. and 64 in. dia. by 45 in. stroke, and when the engines are running at 90 revolutions with 180 lb. steam, each set is estimated to develop 2,500 horse power.

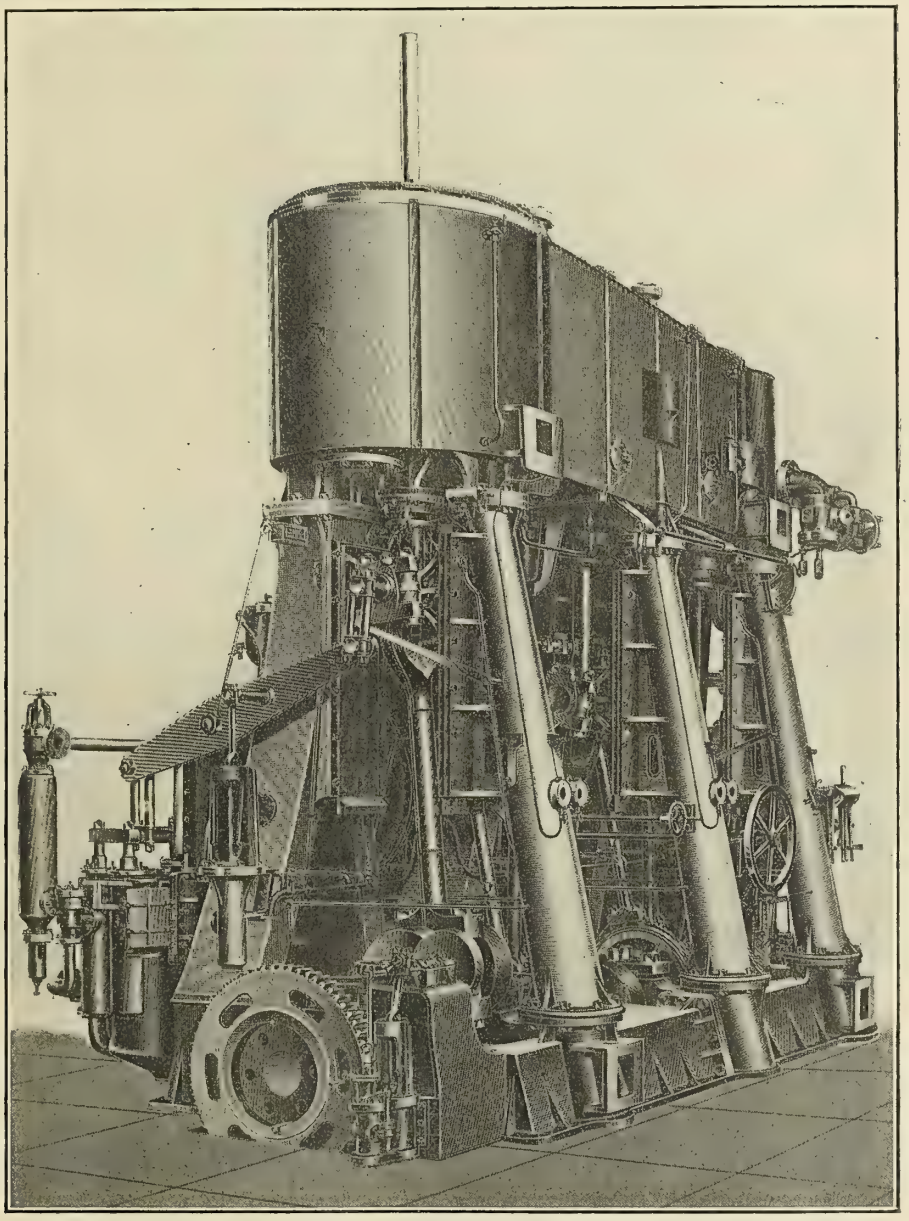
The high pressure cylinders have piston valves fitted with solid adjustable packing rings with extra wide bearing surfaces. Steam enters at the center of the valves; the top valve head is 1-2 in. greater diameter than the lower one. The intermediate and low pressure cylinders have double ported slide valves with balance pistons at the top of each. The valves are secured to the spindles by large square washers at the bottom, and iron washers and double brass nuts at the top.

The pistons are strong box castings well ribbed. The

follower plates are very deep, and the bolts securing them are of large diameter fitted into brass nuts which are screwed into the pistons and held by stop pins. The follower plates and block rings are in one piece with the packing rings sprung in to the grooves between, so that all can be removed together. The high and intermediate pressure pistons each have three

Firth hydraulic pressed steel. The propellers have removable manganese bronze blades.

Steam exhausts into a circular condenser supported by, but not a part of, the engine housings. Air and bilge pumps are driven by arms from the low pressure cross heads. Water is circulated by independent centrifugal pumps. The condensed steam passes through



ENGINE OF S.S. PORT ROYAL OF THE WEST INDIES TRADE.

Ramsbottom rings, and the low pressure, McLaine rings.

All bearing surfaces are exceptionally large. The piston rods 6 1-2 in. dia. are of forged steel and packed with Cleveland metallic packing. The connecting rods are of iron; the crank pins are 13 in. dia. and 15 in. long; the webs are of forged iron; the crank and thrust shafts are of 12 3-4 in. diam., and the cranks are at angles of 120 deg. from each other, the high pressure leading. The tunnel shafting is 12 1-8 in. dia. and of a Hocking filter and Weir feed heater to a pair of Weir boiler feed pumps.

There are four, three furnace, main boilers 16 ft. dia. and 12 ft. long fitted with the Howden system of forced draft. The boiler tubes are 2½ in. outside dia. No. 8 w. g., and 8 ft. 2 in. between plates. The total heating surface for the four boilers is 12,000 sq. ft. The boilers are arranged in pairs and back to back, making two stoke holes. The stack is 10 ft. dia.

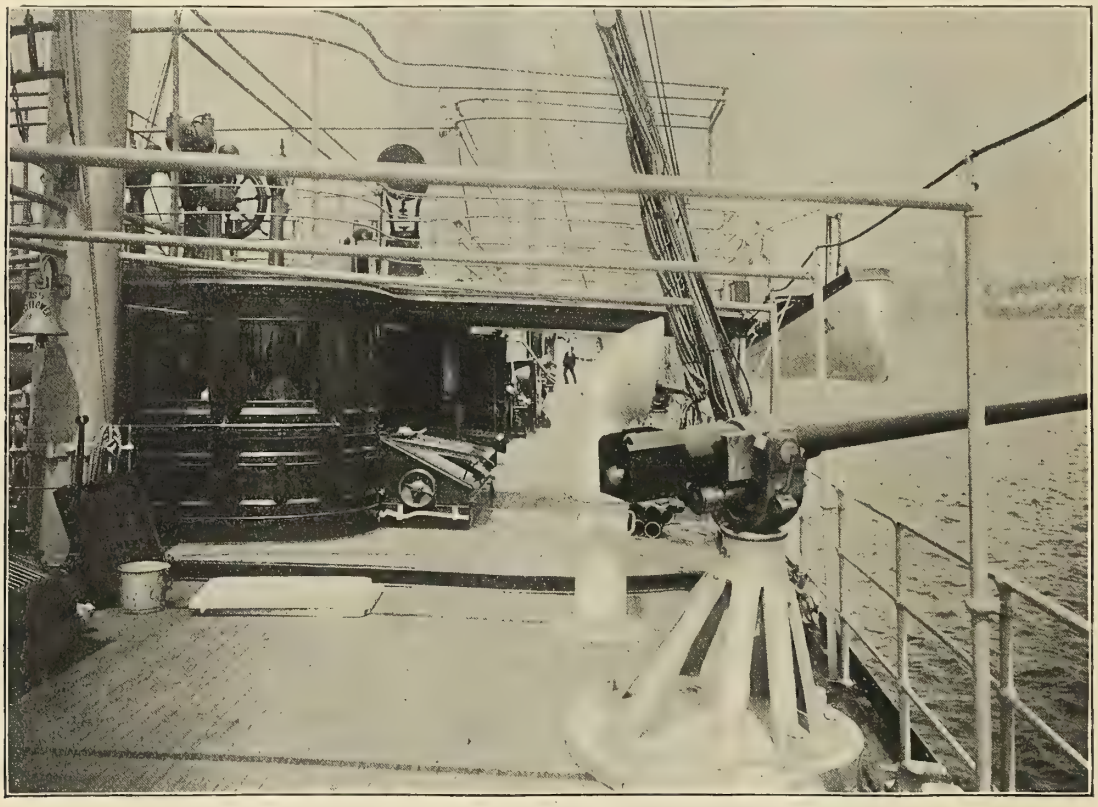
THE U. S. S. MAYFLOWER.

The U. S. S. *Mayflower* has the honor of standing at the head of the long list of vessels added to the Navy during the Spanish-American War by purchase from private owners. When the blockade of Cuba was determined upon it was realized that large numbers of ships would be needed to make the blockade effective, and that small or moderate sized vessels of high speed would be of special use for this purpose.

The yacht *Mayflower* was built by Messrs. J. & G. Thomson, Clydeband, for Mr. Ogden Goelet from designs by Mr. G. L. Watson. She was launched November 7, 1896, and after short use by her owner was sold to King Leopold of Belgium in January, 1898. For some reason, however, she was not taken abroad at the time, and naturally attracted the attention of the naval authorities, who were especially on the look out for vessels of such type as could be readily converted into light and fast gunboats. Her purchase was therefore effected by the Government at the price of $430,000. The *Mayflower* as a yacht was one of the largest and finest vessels ever constructed for an American yachtsman. Her leading dimensions are as follows: Length on water line, 275 ft.; length from fiddle head to taffrail, 320 ft.; beam, 36 ft. 6 in.; depth from bridge deck, 30 ft.; draft, 17 ft. 6 in. The rig is that of brigantine with fidded topmast, and jibboom. She is divided by steel bulkheads into nine separate compartments, and is designed to float even if any two of these should be filled simultaneously with water.

With a coal capacity of 530 tons, the endurance of the *Mayflower* is about 2,000 miles at full speed, or 6,000 miles at a speed of 12 knots.

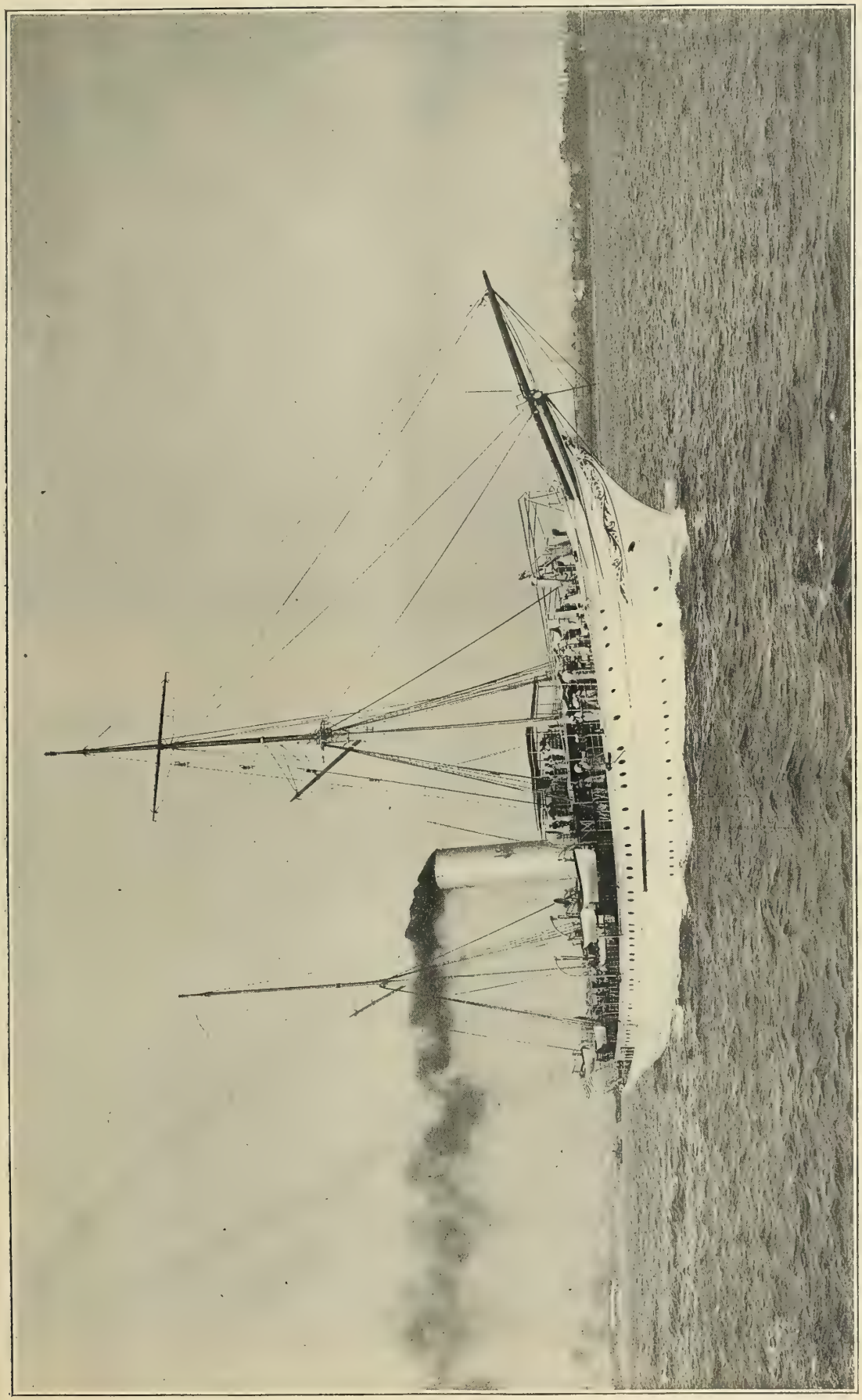
The propulsive power consists of twin screw four cylinder triple expansion engines, with cylinder diamcters of 22 1-2 in., 38 in. and two of 40 in. each, and a stroke of 27 in. Steam is furnished by two single ended four furnace boilers 17 ft. 6 in. dia. and 11 ft. 8 in. long. The boilers are placed back to back and are fitted with Serve tubes and Morison furnaces. The grate surface is 212 sq. ft. and heating surface 6,600 sq. ft., giving a ratio between the two of 1: 32. The combustion is maintained by ash-pit draft, and the normal steam pressure is 170 lb. gage. The revolutions for full power are about 160, and corresponding power about 3,600.



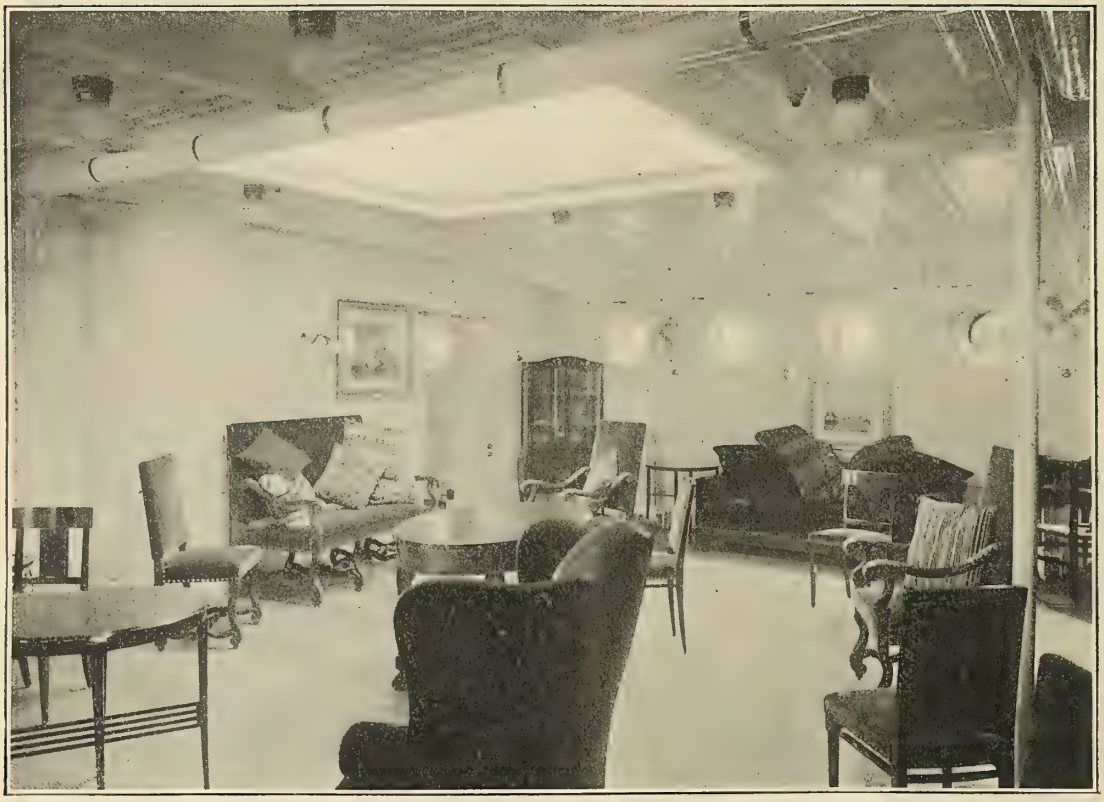
VIEW ON DECK U. S. S. MAYFLOWER.

The armament consists of two 5 in. quick fire guns, twelve 6 pdrs., two 6 millimeter colts rapid fire guns and two torpedo tubes.

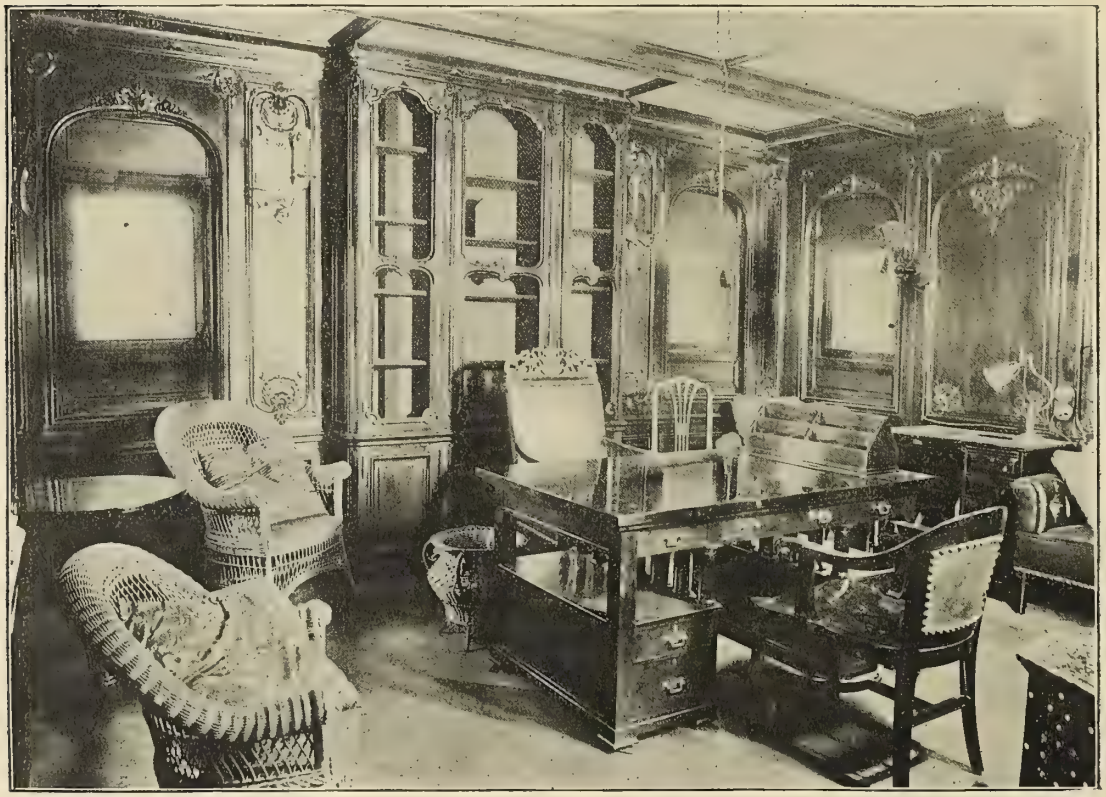
During the Spanish-American War the *Mayflower* was under the command of Commander M. R. S. Mackenzie, and was active in the Cuban blockade and in the operations along the Cuban coast. After the close of the war she was ordered north to the Navy Yard, New York, where she remained until July, 1900. when she was again commissioned and ordered to special duty in the West Indies with headquarters at San Juan, P. R. About the middle of last April she was again ordered north to the Navy Yard, Norfolk, Va., where she remained about a month and then returned under orders for a cruise to Venezuela.



THE U. S. S. MAYFLOWER STEAMING OUT OF NEW YORK BAY.



RECEPTION AND SITTING ROOM.



LIBRARY, U. S. S. MAYFLOWER.

MUSIC ROOM.

SMOKING ROOM, U. S. S. MAYFLOWER.

STEAM JACKETS AND THEIR INFLUENCE UPON THE EFFICIENCY OF THE STEAM ENGINE.

The mechanical energy given out by a steam engine represents only a small part of the total amount of the energy which is transferred to the water in the boiler in the form of heat, in order to convert it into steam. The ratio which the mechanical energy exerted by the steam, bears to the total amount of energy in the form of heat expended in its generation, is called the efficiency of the engine, a value which varies within wide limits with the type of engine. The gain that may be expected to result from jacketing an engine depends on such a multitude of considerations—relating not only to the design of the engine and of the boiler, but also to the management of the machinery under steam—that it can only be very generally stated as lying between 5 and 25 per cent. of the total feed water evaporated. In the case of modern marine engines of good construction, the gain is probably not over 10 per cent. of the total feed water evaporated.

From an economical standpoint, the design of every engine should be such that the greatest possible amount of work may be obtained from a given expenditure of heat; in other words, a given weight of steam should be capable of producing the greatest possible amount of work. In practice, however, it is not always possible to accomplish this, because very often the design of an engine is guided by conditions which have to be considered before economy. The best results are obtained in stationary engines where the valves are designed with a view of reducing the clearance spaces to a minimum, and where the valve gear permits of a high rate of expansion. In marine engines the conditions in general are not so favorable as far as economy is concerned, although in triple expansion engines of latest design, used in the merchant marine, the results are very satisfactory.

As is well known, the efficiency of the steam engine, generally speaking, can be increased in two ways. One way is by reducing the back pressure on the piston by the principle of condensation; a second way, by making use of the expansive force of steam.

Although it is only in comparatively recent years that so much attention has been devoted to the development of high rates of expansion in order to attain economical results, we find that James Watt, as early as 1769, indicated the gain that would result from the utilization of the expansive power of steam. At the same time he had already a clear conception of all the principles and the general conditions necessary for the most efficient and economical working of his engine. It is remarkable how sound these conclusions were, as the same principles hold good to-day as in the time of Watt.

Perhaps it may be of interest to state Watt's principles in his own words. In his publication of 1769 he says: "My method of lessening the consumption of steam, and consequently of fuel in fire engines consists of the following principles:

"First.—That vessel in which the powers of steam are to be employed to work the engine, which is called the cylinder in common fire engines, and which I call the steam vessel, must during the whole time the engine is at work, be kept as hot as the steam that enters it; first, by enclosing it in a case of wood or other material that conducts heat slowly; secondly, by surrounding it with steam or other heated bodies; and thirdly, by suffering neither water nor any other substance colder than the steam to enter or touch it during that time.

"Secondly.—In engines that are to be worked wholly or partially by the condensation of steam, the steam is to be condensed in vessels distinct from the steam vessel or cylinder, though occasionally communicating with them. These vessels I call condensers, and whilst the engine is working, these condensers ought to be kept as cold as the air in the neighborhood of the engine by the application of water or other cold bodies.

"Thirdly.—Whatever air or other elastic vapor is not condensed by the cold of the condenser, and may impede the working of the engine, is to be drawn out of the steam vessels or the condensers by means of pumps wrought by the engines themselves or otherwise.

"Fourthly.—I intend in many cases to employ the expansive force of steam to press on the piston, or whatever may be used instead of them, in the same manner as the pressure of the atmosphere is now employed in ordinary fire engines. In cases where cold water cannot be had in plenty, the engines may be wrought by this force of steam only by discharging the steam into the air after it has done its office."

This clearly shows how James Watt practically introduced all the principles required for the economical operation of modern steam engines. A device for cutting off the admission of steam in his engine, so as to make it work expansively, was invented by him in the same year of his publication. However, Watt did not use it until 1776, and only published it in 1782, when it was patented together with his invention of the double acting engine.

The steam jacket was also introduced by Watt, although it is not certain that he understood its principles and its limitations as they are understood at the present day. He introduced it, only to be abandoned again by those who succeeded him, as his successors failed to see that any benefit could be derived from the use of a steam jacket. It was not until the thermodynamic principles and the action of steam in a steam engine became better known, and the introduction of high rates of expansion—which was made possible by high steam pressures—that the steam jacket was introduced again and its beneficial results better realized.

It may be mentioned, however, that the value of the steam jacket is beginning to decrease for the modern high speed triple and quadruple expansion engines, compared with the importance which has been claimed for it, in the case of the older slow speed simple engines. In the modern steam engine, the mere presence of a jacket does not necessarily indicate an increase in efficiency, because under certain conditions steam jackets may not only be of no benefit, but actually have a tendency to give rise to a loss.

Before entering in detail into the several conditions under which steam jackets do give economical results, in other words, act favorably upon the steam performing work in the cylinder, it may be well to consider first the actions of steam in a cylinder which is not provided with a steam jacket, as this will lead to a better understanding of the functions of the jacket.

If for the sake of illustration we take the cylinder of

a simple engine, or the low pressure cylinder of a compound engine, and investigate the action of steam during the different periods, we find, in the first place, that the steam from the boiler enters the cylinder after the latter has been in communication with the condenser or the atmosphere, as the case may be, for a complete stroke. It therefore comes in contact with surfaces which have a lower temperature than the steam itself. The result is that a quantity of steam will be immediately condensed on these cool surfaces, and the heat given up by the condensed steam will be expended in raising the temperature of the cylinder. From the laws which govern the condition of saturated steam it is evident that a condensation must take place, because for each temperature, saturated steam possesses a corresponding density, which is the greatest density the vapor can have without being partially or wholly condensed into the liquid form. In other words, saturated steam is just at the point of condensation, and the slightest increase of pressure or decrease of temperature will effect a condensation. This is what happens during the period of admission, and when first discovered in the older slow speed simple engines, it was found that the loss of steam due to condensation was very considerable, the steam being fairly absorbed by the cylinder walls, up to a point where the temperature of the inner surfaces had been raised to that of the entering steam. The steam which is thus condensed is deposited as a film on the inner surfaces of the cylinder, and in this state it allows heat from the steam to pass through it more readily than would be the case if the inner surfaces were covered with dry steam.

During the period of expansion a further portion of steam is liquefied, due to the work performed by the steam during expansion. As the steam pressure falls, and the temperature is reduced below that of the metallic surfaces of the cylinder, the film of water which has been formed and deposited on the inner surfaces through condensation, begins to evaporate, and continues until its temperature equals that of the expanding steam, and at the same time extracting heat from the cylinder walls.

In the case of a condensing engine the steam pressure is reduced to that of the condenser during the exhaust period; that is, to a pressure of about 3 to 4 pounds absolute. During this period the rate of evaporation becomes much more rapid than during the expansion period, which results in a further abstraction of heat from the cylinder. This is the heat which was originally abstracted from the entering steam, and goes direct to the condenser, whereby it not only does no useful work, but increases the back pressure on the piston to an extent sensibly felt in unjacketed engines. The cylinder, at the close of the exhaust period, being in a comparatively cool state, fresh steam again enters and goes through the same process as described.

This process is repeated at every stroke, and modern researches have shown that the loss of steam due to condensation during admission and expansion, and the evaporation during the exhaust period is by far the greatest loss in the steam engine; far greater than the loss due to leakage through pistons, valves, stuffing boxes, etc., in carefully constructed engines.

As soon as the true nature of the action of steam in a cylinder became better known, and high rates of expansion became general, steam jackets were again introduced in order to gain full benefit from the expansive force of steam. Although the general conditions of jacketed cylinders are similar to those unjacketed, the superiority of jacketed over unjacketed cylinders has been demonstrated by experiment and actual experience, and up to the present time steam jackets are usually regarded as necessary to carry out high rates of expansion efficiently, and thereby attain the greatest possible economy. The liquefaction which takes place in a cylinder cannot be avoided altogether, even with the use of steam jackets, because we still have to deal with good conductors of heat. Nevertheless, the main object is to reduce the liquefaction to a minimum, and in this respect jackets are very efficient, if properly used. The changes of temperature in a jacketed cylinder are far less than in one unjacketed, as heat is transmitted from the outside surface of the cylinder wall to the inside, thereby raising the mean temperature of the cylinder very considerably. The advantages derived are that the condensation during the period of admission is reduced, since the difference of temperature between the entering steam and that of the metallic surface, with which it comes in contact, is much smaller than is the case in unjacketed cylinders. Further than this, the small quantity which is condensed and deposited as a film of liquid on the metallic surface is for the greater part evaporated again during the period of expansion. This, however, means an increase of useful work, instead of a direct loss as in the unjacketed cylinder, where this evaporation takes place during the exhaust period, thereby increasing the back pressure on the piston.

At first, steam jackets were fitted around the barrels of cylinders only; later they were also added to the covers and heads, and in some instances even the pistons were designed to be steam jacketed, thus causing the steam during its admission and expansion to be entirely surrounded with a steam jacket. The greatest advantage is, however, derived from jacketing the barrels, because the friction of the piston keeps the surface of the cylinder clean, a condition which has a tendency to increase condensation as well as the conduction of heat. On the other hand, the ends of the cylinder are of secondary importance, as these surfaces become covered with a deposit, which interferes, to some extent at least, with the passage of heat through them, and for this reason the efficiency of jackets is correspondingly reduced. As far as jacketing the piston is concerned, it involves of necessity a complicated arrangement, and for this reason pistons are now seldom jacketed.

The quantity of steam lost in a jacketed cylinder through condensation depends not only upon the condition of the jacket steam, that is, whether its temperature is high or low, but the efficiency is to a large extent affected by the manner in which the heat from the jacket steam acts upon the cylinder. Experience has shown that if the steam is allowed to circulate through the jacket, the results are far better than if the steam is at rest. This is evident, because if the steam circulates through the jacket, the hot steam is constantly replacing that which has been cooled off on the cylinder walls.

In all modern steam engines provided with jackets, the steam is supplied to the jackets through separate branches connecting with the main steam pipe, an ar-

rangement which is to be recommended as giving the best results. To cause the steam on its way to the cylinder to flow through the jacket is not the best plan, and should be avoided, as the steam is cooled in the jacket, thus causing a condensation and a decrease in the initial pressure, resulting in a loss of efficiency.

It has already been stated that the value of steam jackets varies within wide limits, depending upon a number of conditions, and in some cases they may become totally useless. In the first place, it is not difficult to show that the value of a jacket is reduced with increasing diameter of the cylinder; that is, jackets are less efficient in large cylinders than in small ones, other conditions remaining the same. For instance, a cylinder with a diameter of 3 ft. and a stroke of 4 ft. has a total internal surface on one side of the piston of 44.74 sq. ft. The corresponding volume which the steam occupies during one stroke of the piston is 28.26 cu. ft., which gives 1.58 sq. ft. of effective heating surface to every cubic foot of steam in the cylinder. If, for comparison, we take a cylinder 9 ft. in diameter and 4 ft. stroke, we have an internal surface of 176.628 sq. ft. and a volume of 254.32 cu. ft., giving in this case .695 sq. ft. of effective heating surface to 1 cu. ft. of steam. We may assume, therefore, that the jacket of the smaller cylinder is 1.58 : 0.695 or 2.3 times as efficient as that of the larger cylinder.

Again, the piston speed may influence the value of the jacket to a great extent, and it can be generally stated that the higher the piston speed of an engine, the more is the value of the jacket reduced. A similar reasoning applies here as in the first instance, and if for the sake of illustration we assume a piston speed of 4 ft. a second, then with a stroke of 2 ft. the cylinders will be filled with steam once every second. Suppose now the same piston to move with a velocity of 16 ft. per second, a very common piston speed in modern marine engines. The cylinder is filled four times every second, and since the effective heating surface for the same cylinder remains unchanged in each case, it is evident that the efficiency of the jacket will be greater with the slower piston speed. With slow speeds, the cylinder has more time in which to abstract heat from the steam during admission and give it up again during exhaust than is the case with high speed engines, and therefore the value of the jacket becomes less in proportion as the piston speed is increased. For this reason steam jackets applied to modern high speed engines do not have the importance which has been claimed for the older slow speed engines.

The temperature of the jacket steam is evidently of consequence, because the lower the temperature in the jacket the more will the mean temperature of the cylinder walls be reduced, and the less will the condensation during the admission period be prevented and the more will evaporation during the exhaust period be increased. The temperature of the jacket steam should be at least that of the entering steam in the cylinder, and better results can be expected if the temperature is even higher in the jacket.

A proper drainage of a jacket is essential, because a jacket filled with condensed steam cannot give good results. The loss of steam due to the omission of careful drainage can be far greater than would perhaps be the case if the jacket had been omitted entirely, because instead of heat passing to the cylinder it may pass from it, being absorbed by the water in the jacket. Steam jackets are without exception used to warm up the cylinders before starting, and if any water is allowed to remain in the jackets after stopping the engine, those parts of the cylinder which are covered with water remain practically unaffected by the steam, thus causing unequal expansion. This has often been the cause of cracked cylinders. In order to insure the constant drain of jackets, an automatic arrangement is almost indispensable, thus excluding all negligence on the part of the persons in charge.

It has also been found that the condensation in a well lubricated cylinder is reduced to some extent, and with that the consumption of steam as a whole. A film of oil deposited on the inner surface of a cylinder prevents the rapid passage of heat from the entering steam to the cylinder walls.

This is perhaps one reason why on trial trips, where the lubrication, as a rule, is far beyond that used under ordinary conditions, the results as to steam consumption are often found to be much better than afterwards.

In modern steam engines, where steam is expanded in three or four cylinders, the difference of temperature between the admission and exhaust periods is less than in the cylinders of a simple expansion engine. In a simple expansion engine, working with a boiler pressure of about 75 lb. per sq. in., the temperature of the entering steam is about 318° and that of the exhaust into the condenser about 150°, giving a difference of temperature of 170°. In modern triple expansion engines, working with a steam pressure of 180 lb., the steam enters the H. P. cylinder with a temperature of about 379°, and leaves the L. P. cylinder with about the same temperature as with the simple engine. Assuming that in the triple expansion engines the total drop of temperature is divided evenly among the three cylinders, the drop of temperature in each cylinder would only be less than 100°, instead of 170°, as in the simple engine, and therefore the cylinder walls will be cooled off less during each stroke. If steam jackets are omitted, it is evident that the condensation in the simple engine must be much greater than in the triple expansion engine with a much smaller drop of temperature. This leads to the conclusion that the value of steam jackets is less in modern high speed multiple expansion engines than in slow speed simple expansion engines. With the constant increase of steam pressures and piston speeds the limit of the value of the steam jacket is already in sight, and where weight is of first importance they can already be omitted without affecting the economy appreciably, as, for instance, in the case of torepdo boat engines. It is found sufficient to cover such cylinders with a non-conducting material. This also keeps a certain amount of moisture in the steam, and to a certain extent takes the place of a lubricant. Most lubricating materials are more or less affected by high temperatures, and where steam pressures of 200 lb. and over are used, lubricants may be evaporated, and as such are useless.

This is an additional reason why jackets for the high pressure cylinders of modern high speed triple expansion engines, working with a steam pressure of 200 lb. and over, can be omitted with good results. With such high pressures, the effects of cylinder lubrication are doubtful, and if jackets are omitted for high pressure

cylinders the steam will be kept sufficiently moist to act as a lubricant, without affecting the condensation to a serious degree.

As far as the intermediate pressure cylinders are concerned, opinions differ as to the necessity of steam jackets. Some engineers claim it is better to omit them, others seem to think the opposite. At the present time the general practice seems to be in favor of them. However, the loss of steam cannot be very great, even if not provided with a jacket, because any steam which is again generated during the exhaust period is still capable of doing useful work in the low pressure cylinder.

With low pressure cylinders the conditions are somewhat different. In the first place, the drop of temperature is usually greater in a low pressure cylinder than in the intermediate or high pressure cylinder, consequently the difference of temperature between the entering steam and the cylinder walls will also be greater, which, as has been explained, increases the condensation. The evaporation which takes place during the exhaust period of an unjacketed cylinder would in this case cause a considerable amount of steam to pass to the condenser without doing any useful work. For these reasons low pressure cylinders of modern triple expansion engines should be provided with steam jackets, where possible, to give economical results. But where economy of weight is of first importance, as is the case with torepdo boat engines, jackets are also omitted on low pressure cylinders. In such extraordinary cases it can be done without affecting the efficiency appreciably. It must be remembered that these engines work with steam pressures up to 250 lb., piston speeds up to 1,200 ft. per min., and have a cut off of about 75 per cent, all of which conditions decrease the value of a steam jacket.

Naval engines are generally designed with higher piston speeds than those for the merchant marine, and in view of the importance of the reduction of weight in naval engines, steam jackets may soon be altogether omitted. This can be done without affecting the economy to any great extent.

From the designer's standpoint, jackets will always have an advantage, because their use permits of the insertion of a separate working liner, which is always made of harder material than the cylinder casing, giving a better wearing surface and providing for replacement when worn out.

Clyde Line Steamship Apache.

The latest addition to the fleet of the Clyde Line is the steamship *Apache*, built by the Wm. H. Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa. This ship is to run on the New York, Charleston and Jacksonville line with the present steamers *Algonquin*, *Comanche* and *Iroquois*.

Several innovations from the usual plan of coasting steamers have been made in the *Apache* which give her big cargo carrying capacity and commodious passenger accommodations. All the cabins are above the upper deck, leaving large holds for the cargo. Most of the state rooms are located aft off the main saloon on the upper deck. A broad passageway leads forward on the starboard side to the large dining saloon located directly below the pilot house and with windows opening on front and sides. Aft this come the pantry and galley, and on the port side are the engineers' quarters. On the bridge deck, which runs from stern to foremast, are the upper saloon, several deck staterooms and the officers' quarters and pilot house. The accommodations are for 200 passengers. The second cabin and crew space are located in the forecastle.

Her general dimensions are:

Length over all	310 ft. 0 in.
Length between perpendiculars	284 ft. 6 in.
Beam	46 ft. 0 in.
Depth to main deck	20 ft. 6 in.
Depth to upper deck	31 ft. 0 in.
Gross tonnage	3,378 tons
Cargo capacity	3,000 tons
Speed	15 knots

NEW CLYDE LINE S.S. APACHE.

The engine driving the single screw is triple expansion, inverted direct acting with cylinders 25 in., 43 in. and 70 in. dia. by 36 in. stroke. The three cylinders are fitted with piston valves, one for the high pressure, and two each for the intermediate and low pressure cylinders. Steam is supplied by two Scotch boilers 16 ft. 6 in. dia. by 10 ft. 5 in. long, with Howden forced draft.

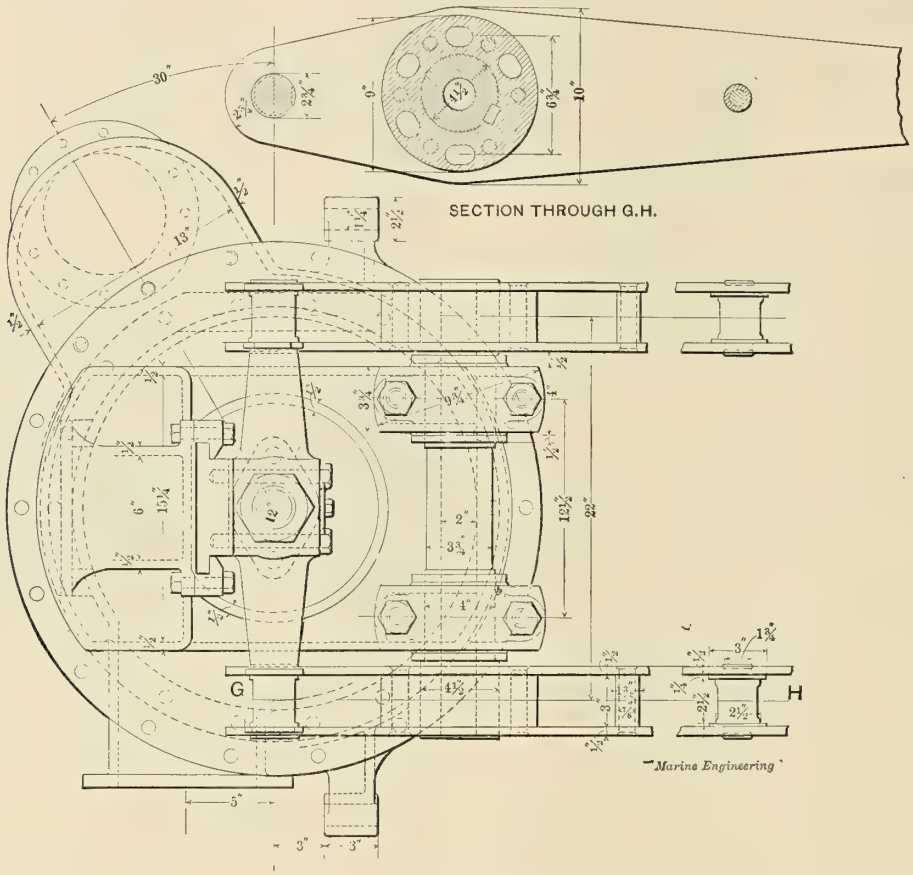
Direct Driven Air Pumps.

An interesting design of direct driven air pump—shown in the drawings on the neighboring pages—is that adopted for the engines of the *Denver* class of U. S. cruisers. In former issues extensive general descriptions of these vessels and of their propelling engines have been published. It will be recalled that the cruisers are vessels of about 3,200 tons displacement, with twin screw engines of 4,500 I. H. P., sufficient to give a maximum speed of 16 1-2 knots. The engines are of the triple expansion, four cylinder, four crank type, with cylinders 18 in., 29 in. and (two) 35 1-2 in. dia. and 30 in. stroke. With a steam pressure of 250 lb. at the high pressure end, the engines will turn about 172 revolutions per minute at full speed.

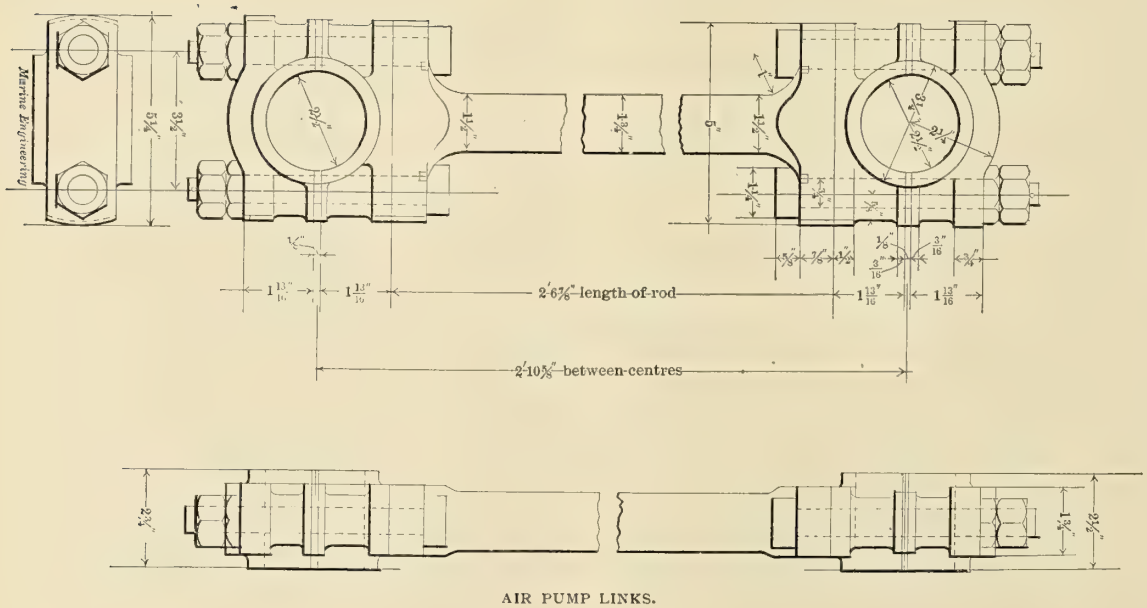
In design these vessels and their machinery are a distinct departure from the usual naval type of vessel in which much is sacrificed in material and arrangement to speed. They represent good conservative practice in which "freak" results have not been sought, and for this reason are more than ordinarily interesting to engineers of the merchant marine.

There is one air pump for each main engine, worked by link and beam connection from the forward low pressure crosshead. The pump is of the vertical, single acting, bucket type, having a diameter of 22 in. and a stroke of 10 in. The pump casing and piston (or

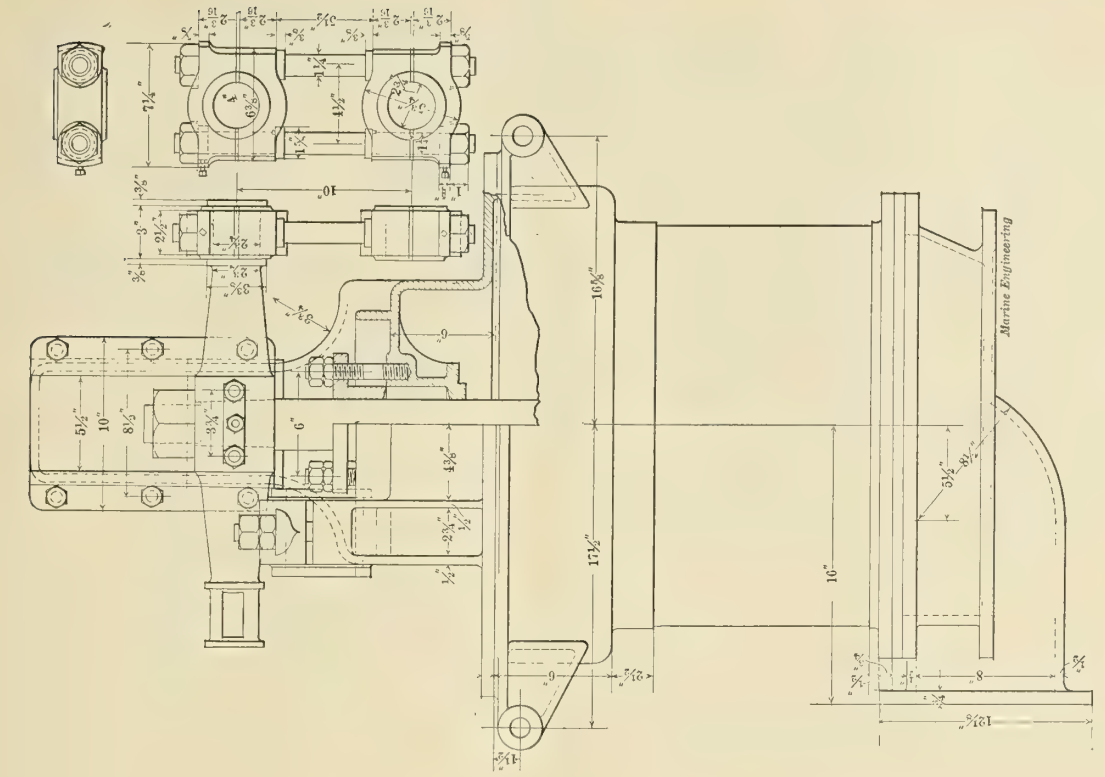
bucket) is made of composition of the Government standard, 88 per cent copper, 10 per cent tin, and 2 per cent zinc. The pump piston rod and all bolts in the casing are rolled manganese, phosphor or Tobin bronze. All other rods, links and forgings are of nickel steel with a tensile strength of not less than 80,000 lb., an elastic limit not less than 45,000 lb., and an elongation in 2 in. of at least 25 per cent.



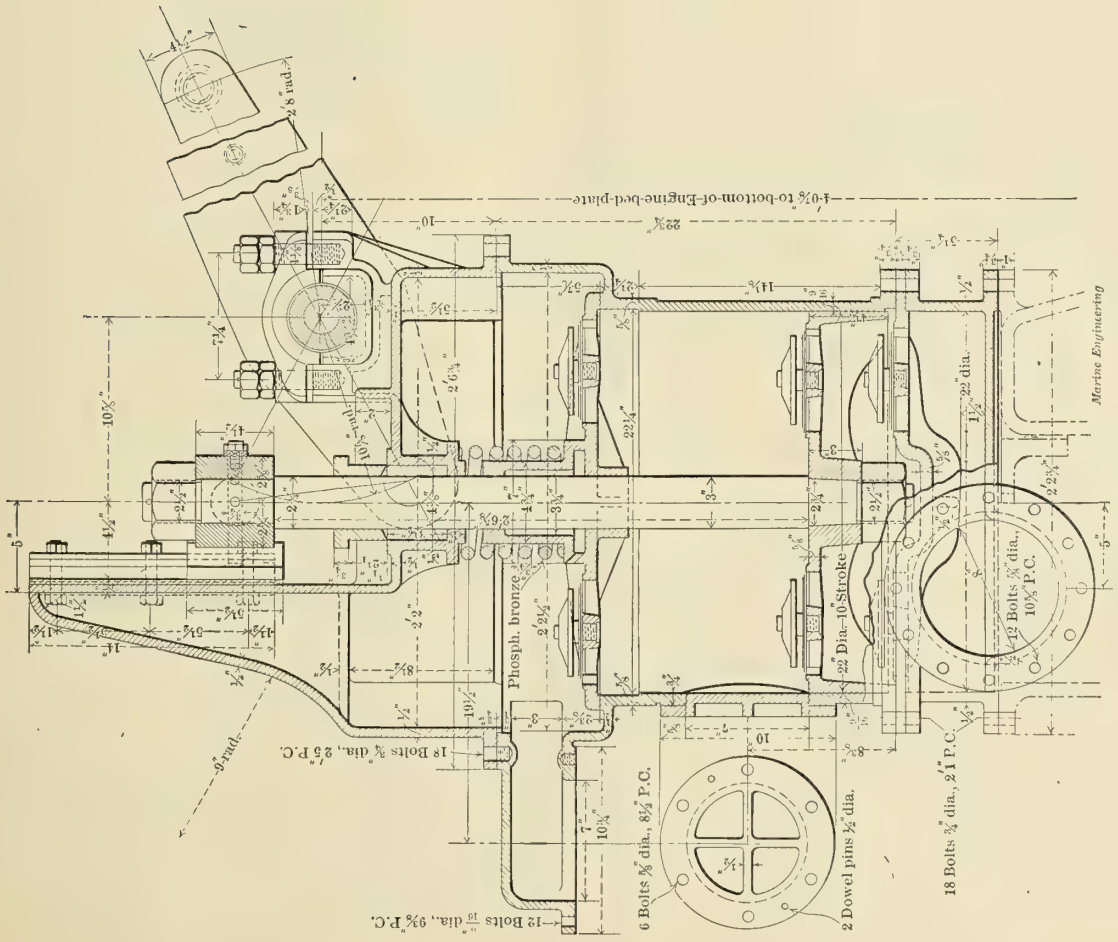
PLAN OF AIR PUMP.



AIR PUMP LINKS.

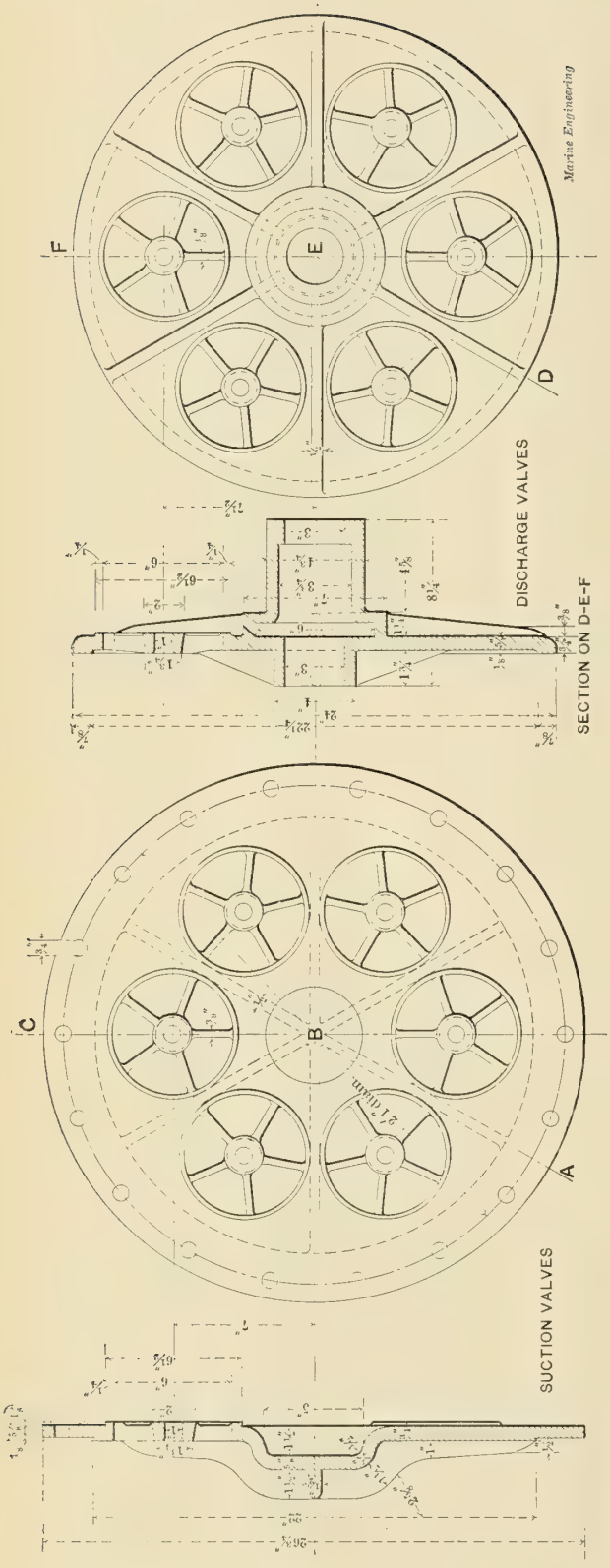


FRONT ELEVATION.

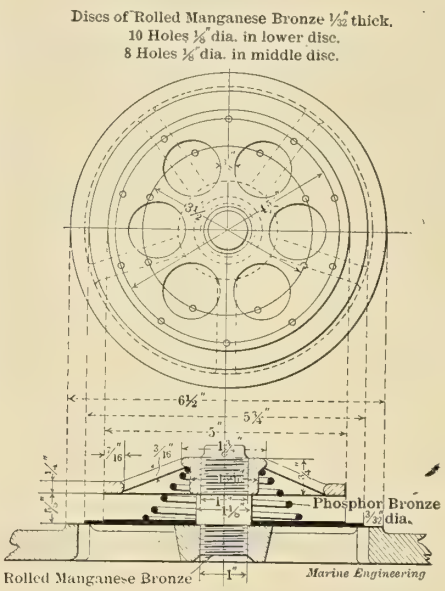

Marine Engineering
Phosph. bronze
22" Dia.–10" Stroke
12 Bolts ⅞" dia., 10¾" P.C.
18 Bolts ¾" dia., 21" P.C.
6 Bolts ⅞" dia., 8½" P.C.
2 Dowel pins ½" dia.
18 Bolts ¾" dia., 25" P.C.
12 Bolts ⅞" dia., 9¾" P.C.

SECTIONAL SIDE ELEVATION.

DIRECT CONNECTED AIR PUMPS FOR DENVER CLASS.



The foot valves, bucket valves and delivery valves are interchangeable, made of three disks of rolled manganese bronze, held in place by a guard and spring of phosphor bronze. The lower valve disc contains ten holes, 1-8 in. dia.; the middle ring, eight holes of the same diameter; and the top ring is unperforated. This type of valve is used very largely in U. S. naval vessels, and gives universal satisfaction. It is required that the valves and guards may be readily removable and, to accomplish this, a collar stud of rolled maganese bronze is screwed into the valve seat, and riveted over at the bottom, the guard being screwed on the


Discs of Rolled Manganese Bronze ½" thick.
10 Holes ⅛" dia. in lower disc.
8 Holes ⅛" dia. in middle disc.
Phosphor Bronze
Rolled Manganese Bronze
Marine Engineering

DETAIL OF VALVE.

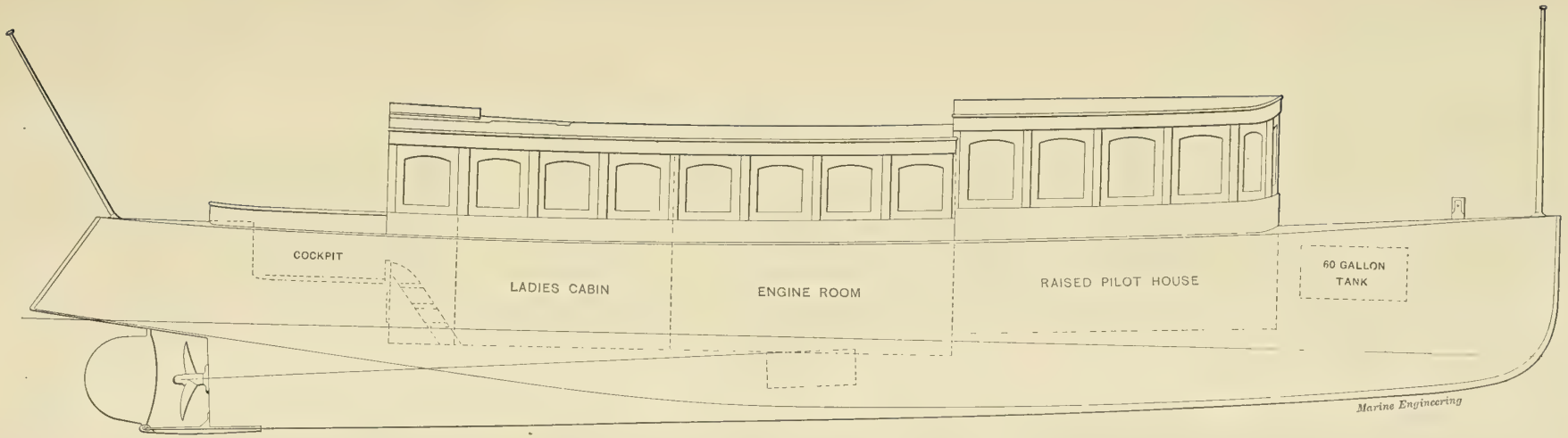
top of the stud above the collar and secured from turning by a split pin.

The delivery valve seat is itself a valve, held in place by a heavy phosphor bronze spring bearing against the pump bonnet. This spring is made with compression enough to prevent the seat lifting at ordinary pressures; but, should the pumps be overloaded, the whole seat will lift, reducing the liability to accident.

Clyde Shipyards.—During the month of May, shipbuilders on the River Clyde launched 32 vessels with an aggregate of 53,411 tons.

Fuel Oil.—An experiment has recently been made on board the British torpedo boat *Ophir*, testing Holden's system of oil burning. According to the report the speed was increased two knots by burning the oil and coal together.

Niclausse Boiler.—Coal consumption trials of Niclausse boilers fitted on the German cruiser *Freya* gave satisfactory results. The designed power of the *Freya* is 10,000 H. P., and on a 24 hour trial at 1,200 I. H. P. the coal burned per I. H. P. was only 1.7 lb. A later trial at 6,000 I. H. P. resulted in 1.72 lb. coal consumed per I. H. P.



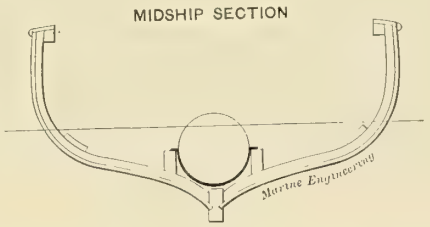
OUTBOARD PROFILE OF A CRUISING MOTOR LAUNCH.

A Cruising Motor Launch.

The accompanying plans show a motor launch of somewhat novel form designed for Mr. Nathaniel L. Moore, of Dorchester, Mass., by Mr. Isaac B. Mills, of Boston.

The purposes which the owner required called for a cabin launch some 42 feet in length, with 6 ft. 3 in. head room everywhere, and with good speed on small propulsive power, the engine proposed being of 10 H. P. only. The construction furthermore was to be strong and durable with elaborate finish for the cabin work.

To fulfil the speed requirement the resistance of the boat must be reduced to a minimum, at the same time retaining in high degree seaworthiness and ability to safely cope with the varying weather conditions of Massachusetts Bay. The chief faults noted by the designer in launches of this description were a tendency to roll, and to dive and pitch heavily when driven into a head sea. To remedy these defects the designer decided upon a somewhat novel form of midship section for craft of this sort, although one which has been well tried in sailing craft of various kinds. This form was one having wide beam, shallow body and a hollow garboard.

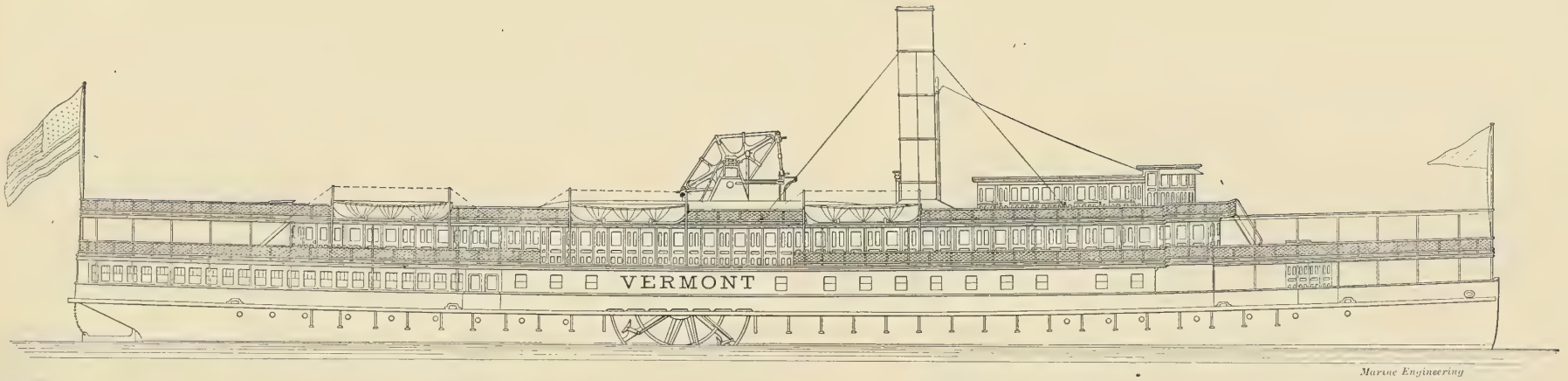


The hollow garboard appeared to offer several advantages. In the little nest formed amidships, the fly wheel of the engine could turn; the center of gravity of the engine would be lowered; the molding size of the bed pieces supporting the engine would be reduced, and these bed pieces would rest upon the crown of an arch, a form best calculated to support weight and reduce vibration; also the angle of the shaft would be brought more nearly horizontal, thus giving a more direct thrust from the propeller. Moreover, from the designer's standpoint, this form of midship section, provided it is coupled with long and easy lines, is conducive to good speed with low expenditure of power.

The result has proven highly satisfactory, both to the owner and to the designer. Her sustained speed is about 10 miles per hour, she is stiff without ballast, is remarkably steady in a seaway, and lifts over the waves in a light and and easy manner.

No small part of the credit for the success of this launch is ascribed to the 10 H. P. engine installed by Murray & Tregurtha.

The internal arrangements of the launch are all that could be desired, comprising a 9 ft. raised pilothouse, 8 ft. engine room with galley and toilet room on port side, and an after ladies' cabin 8 ft. in length, supplied with lockers, mirror, shelf and portable table. There is also a cosy cockpit aft provided with seats.



OUTBOARD ELEVATION OF CHAMPLAIN TRANSPORTATION CO.'S STEAMBOAT VERMONT.

SIDEWHEEL PASSENGER STEAMER FOR LAKE CHAMPLAIN.

The tourist and other passenger traffic on Lake Champlain has increased so rapidly of recent years that the directors of the Champlain Transportation Co. have decided that they need better and more modern facilities for handling the business, and they have awarded to the W. & A. Fletcher Co., of Hoboken, N. J., the contract for building a new steamer of modern type and with specially good passenger accommodations.

This boat was designed by J. W. Millard, of 32 Broadway, New York, and reference to the plans will show a most carefully thought out general arrangement in conjunction with a pleasing appearance.

The plans call for a steel sidewheel boat 250 ft. long at the water line and 263 ft. over all. The breadth molded is 35 ft. and breadth over all 63 ft. 6 in., while the depth at the lowest point of sheer is 11 ft. 3 in. to the base line.

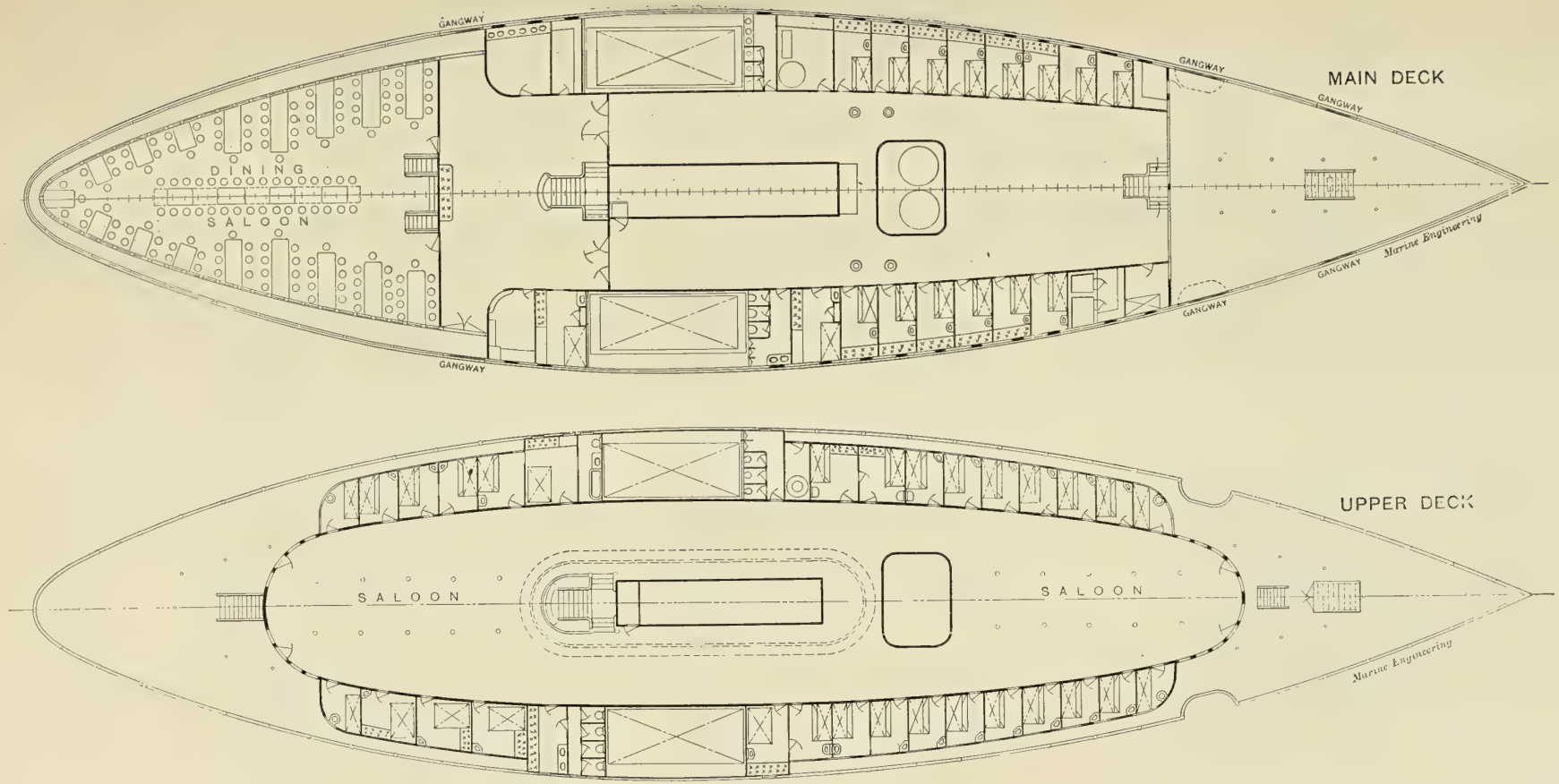
The steel hull of the vessel is especially designed to obtain the greatest amount of strength on the lightest scantlings, and the proportions and disposition of the materials are based on the experience gained in building light and comparatively shallow hulls, both in this country and abroad, rather than on the rules of any classification society. Especial attention has been paid to getting sufficient longitudinal strength to take care of the strains produced by the high engine power and the location of the weights in a boat of this type.

The engine is of the vertical beam type with jet condenser and feathering wheels. The diameter of the cylinder is 55 in., and the stroke of piston 10 ft. The designed I.H.P. is about 1,800. There will be two return tubular boilers 26 ft. 6 in. long, 9 ft. 6 in. diameter, 11 ft. 6 in. across the front, and carrying steam of about 50 lb. gage pressure. There will be also a donkey boiler of the vertical tubular type located, together with the donkey pump, on the main deck at the forward side of the wheel.

The vessel will be lighted throughout by electricity, the outfit consisting of a direct connected engine and dynamo, with capacity for about 250 incandescent lights and arc search light.

The accommodations are as follows: Beginning on the lower deck forward is the forecastle for the crew, and a separate room for the firemen. Abaft that is the bar and lunch room, fitted up in hard wood, and entered by a double stairway from the main deck. Then comes the machinery space, aft of which are the kitchen and pantries. These are exceptionally large and will be fitted up with modern appliances for cooking and serving meals for a large number of people. A dining room for officers and sleeping rooms for the stewards complete the arrangements below the main deck. A special feature is the fitting of two stairways from the pantry to the dining room on the main deck, so that the waiters do not interfere with one another. Beginning aft on the main deck is a large dining room capable of seating 150 persons at the same time. This room will be glazed completely around with plate glass, the windows being kept low in order that people sitting at the tables may have an uninterrupted view of the outside.

Forward of the dining room is the entrance recess, where is located the ticket office, parcel room, and a commodious wash room and barber shop. Here is also the main stairway to the upper saloon, and of which a special feature is made, as is common with boats of this type. Forward of the wheel enclosure on the main deck on each side will be fitted large state rooms, each with two berths and a sofa lounge.



DECK PLANS OF CHAMPLAIN TRANSPORTATION CO.'S STEAMBOAT VERMONT.

There are thirty state rooms on the saloon deck, of different sizes and arrangements, so that almost any requirement can be met; many of them are en suite, and are fitted with brass bedsteads, in place of the ordinary ship's berth. All the berths on the boat will be made removable, so that the rooms can be rearranged to suit changing conditions and requirements. The whole of the hurricane deck will be given over to the passengers, with the exception of the pilot house on the forward end; there will be six state rooms abaft the pilot house and a comfortable smoking room in the rear of these.

The steamer will carry six life boats on davits, and one life raft. She will be steered by steam steering gear, and her speed will be about 21 miles per hour.

CAPSIZED IN DRY DOCK.—The U. S. transport *Ingalls*, while being dry docked at the Erie Basin, Brooklyn, N. Y., on June 14, fell over upon her side owing to a misplaced bilge block and insufficient shoring. Most of the rigging and top hamper was carried away or severely damaged, and one workmen was killed, and twelve others severely injured. The vessel was righted by large derricks.

SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

Facilities for Study at the Engineering College of the Imperial University of Tokyo, Japan.

BY GEORGE CROUSE COOK.

The Tokyo Teikoku Daigaku or Imperial University of Tokyo, Japan, has existed in its present form since March of the year 1886, when it was established through an Imperial Ordinance of the present Mikado, by the union of two independent colleges, the Tokyo Daigaku and the Kobu Daigakko. The former of these, the Tokyo Daigaku, or Tokyo University, is itself a union of two of the oldest schools in Japan, both of which date from the Tokugawa Government of 1850, and it also brought four of the present six Colleges to the University; the latter, the Kobu Daigakko or Engineering College, is of quite recent origin, having been established for the training of engineers at Tovanomonuchi under the Imperial Bureau of Public Works, where it was continued until the union. The University then consisted of Colleges of Law, Medicine, Engineering, Literature and Science; and when some four years later a College of Agriculture, situated in the suburbs of Tokyo, was added to the University, the present number of six was attained.

The grounds occupied by the University are most favorably situated on the bluffs to the northwest of the beautiful Japanese capital and enclose the various Colleges, with the exception of that for Agriculture, which remains on its original site, together with a number of hospitals, workshops, a library, a museum, offices, residences for foreign professors and an athletic field. The total property of the University at Tokyo consists of about 220 acres of land and some 80 buildings, which are mostly of wood or brick, though a few are formed of steel frames filled in with cement. In addition to this the University has extensive forests in various parts of the country for instruction in practical forestry.

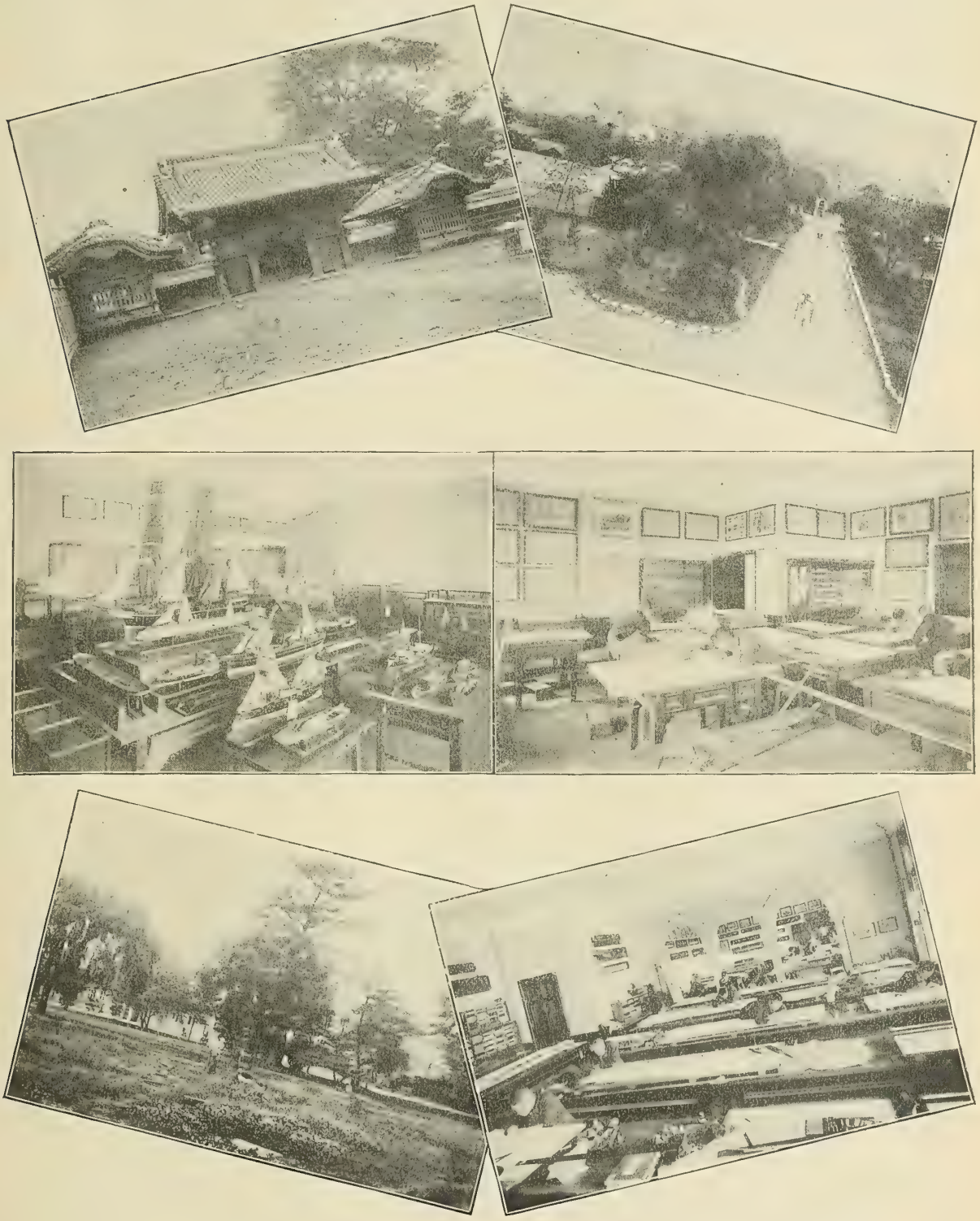
The University, as its name, "Imperial," might imply, is supported by the Government, and for this reason the fees of private students, who are the great majority, are merely nominal. In addition to its private students the University gives instruction in its various departments to cadets for the Government services. The management of the University, under the State Minister of Education, is held by a president, assisted by a council composed of the director and a professor of each of the Colleges. This body handles the finances of the University, introduces or abolishes courses of study, regulates the internal action and has the power to grant or withdraw the degrees of the various Colleges. The presidency of the University, which is an Imperial appointment, confers high court rank, and has been in several cases a prelude to a position of dignity in the Government.

As the modern educational development of Japan has been drawn from foreign sources, the corresponding foreign language has naturally found a positive position among the educated people of the country. The Japanese at the beginning of their development selected with much shrewdness the nation most skilled in each art or science, and introduced its methods, systems and language for their own education in that specific work, so for nearly every College of the University there are foreign professors who teach in their native language and Japanese professors who were trained in this language. The College of Medicine is developed on German lines by German professors, and all of its students must be proficient in the German language, while in the College of Engineering English and English methods hold a similar position. The English, however, is the more popular, as the University Calendar and many of the University publications are translated from the Japanese and issued in this language.

Students for the complete courses are admitted to the University through a preliminary examination or a certificate from some recognized preparatory school, but when the number of applicants exceeds the facilities of the College a competitive examination of the candidates is held, and the best qualified admitted. Each regular course for a degree extends over a period of three years, excepting those for Medicine and Law, which are of four years' duration. Students wishing to take any specific study, as Naval Architecture, in the College of Engineering, must be at least nineteen years of age and show their qualifications to pursue the work of the class by certificates or an examination, and on performing the work of the regular students are granted a certificate of proficiency in this particular study.

The College of Engineering, which is exceptionally well advanced, has about 18 per cent. of the 2,700 students of the University, and consists of well developed Departments in Civil, Mechanical and Electrical Engineering, Naval Architecture, Technology of Arms and Explosives, Architecture, Mining and Metallurgy and Applied Chemistry. The buildings allotted to this College occupy the northeast section of the University grounds, and consist of two large, independent, rectangular, brick buildings of two stories each, containing the class rooms and drawing offices together with several smaller buildings containing laboratories and workshops. The Department of Naval Architecture, which was established as an independent course at the Engineering College in 1881 by a Scotch professor, occupies some five rooms of the larger of these two main buildings and the whole of a smaller adjacent wooden building. A medium sized hall in the College is used as the Museum of the Department, and contains among its one thousand items a few excellent models of modern ships, many models illustrative of the ancient native types of sailing vessels, which are of some historical value, and show the exquisite skill of the Japanese in the execution of small delicate forms, and a number of valuable books and diagrams.

The course of the Department of Naval Architecture taken by regularly entered students seeking the degree of science in naval architecture extends over a period of three sessions, each of which is approximately of ten months' duration; that is, extending from the middle of September to the middle of July, with an occasional national or religious holiday and short winter and spring vacations, which correspond to the American recesses at Christmas and Easter. The attendance expected of the students during these three sessions and which is quite necessary in most cases for the execution of the work, consists of seven hours per day, excepting



ENGINEERING COLLEGE AT THE IMPERIAL UNIVERSITY, TOKYO, JAPAN.

Red Gate or Main Entrance.
Museum, Department of Naval Architecture.
Campus and Engineering College.

General View of Engineering College.
Drawing Room, Department of Naval Architecture.
Drawing Room.

Saturday, which is taken as a half holiday, and Sunday, when all work is laid aside.

During the first year of the course a portion of the time is given up to those sciences which have a direct bearing on naval architecture, still four hours per week are taken for lectures on the special subject and twelve hours per week practical drafting required in the drawing rooms of the College, while some ten hours per week are given to marine engineering lectures and drawing. The theoretical lectures during the year are on the subjects which might be collectively termed calculations, and consist of demonstrations of the methods for finding areas of curves, volumes bounded by curves, etc., with their respective centers and moments; the metacenters, tons per inch of immersion, moment to alter trim, etc., and the graphical representation of these values by curves. The practical lectures first give complete explanation of the various terms and operations of wooden shipbuilding and then advance to similar definitions on iron and steel ships; explanations of the origin, duties and practical value of the registration societies; the characteristics of the different types of merchant and naval vessels and the elements of their construction, the framing, plating, stiffening, riveting and finishing; and additional explanations as are required to define sheathed and composite hulls. Then follow accurate explanations and illustrations of the principles and details of laying-off for wooden and steel ships, both of the conventional merchant forms and special types of naval vessels. The drawing room work associated with these lectures consists of the drafting of a set of lines from offsets, a midship section from the rules of a registration society; the calculation of the displacement, metacenters, etc., for these lines and their graphical representation by curves. A number of drawings of the elements of a marine engine are also required.

At the opening of the second year the naval architecture work takes the leading part, which it holds throughout the remainder of the course, some ten hours per week being given to the lectures and from eighteen to twenty hours per week attendance required in the drawing room. The theoretical lectures first given are on the question of stability, and include the stability of geometrical forms floating in a liquid; the statical stability of the various types of merchant and naval vessels under the conditions which might arise in actual service, the effects of shifting weights or cargo, liquid cargoes and free water in the holds; dynamical stability and its relations with the statical conditions; the practical methods for the calculation of curves and cross curves, of righting arms with and without the use of mathematical instruments, and the correction of the first results due to appendages, free water, etc.; the theoretical consideration of the geometry of stability, etc. The subject is completed by investigations of stability in special conditions, as at launching, in dock, under sail or in heavy seas. The lectures on the theory of resistance and propulsion are developed with a view to practical application, and include explanation and demonstration of the laws of fluid resistance and the power required to overcome this resistance; the efficiencies of the mechanical devices for utilizing this power, the propeller, the paddle wheel, single and twin screws; the relations between the propelling force and the engine indicated horse power; the means of determining required I. H. P. for a given ship at a given speed by known laws or formulæ or by towing the model at corresponding speeds, and also the application of wind pressure for overcoming this resistance.

The series of lectures on shipbuilding materials begins at the mines and forests and carries them to their position on the ship. The list is not confined to an investigation of the properties and strength of the more important materials as steel, iron, copper and the principal woods, but it includes the manufacturing processes and applications of the smaller items as sheathing materials, cement, tar, paint and varnishes. Under the strength of ships, which is the next subject treated, are found investigations of the longitudinal stresses on a ship when floating upright in still water or on a wave, the conventional methods of representing these stresses graphically, stresses due to pitching and heaving, transverse stresses set up in dock, etc., and the stresses due to miscellaneous causes, as from masts carrying sails or engine vibrations; then the provision of strength to resist these stresses by the framing, shell plating, etc., and correctly formed riveted joints at different points. Then follows the subject of ship design, which includes necessary requirements and conditions for determining a design, the correct values of the dimensions in fulfilling these conditions most economically and the estimation of hull weights; the determination of the horse power required to run at a certain speed and general consideration of the dimensions of the boilers and engines to develop this horse power and the size and proportions of the propeller. The subject of waves and rolling, as here treated, consists of a brief history of the investigations on the subject; explanations of rolling in still water and effect of side weights, water ballast, etc., on the period of roll; the desirable and actual periods for different types of vessels. Wave formation is then exhaustively treated and the rolling and pitching of ships among waves considered, the value of water chambers, bilge keels, etc., and the actual estimation of angles and periods of roll. The theoretical lectures are then completed by a series on the steering of ships, which treats of the various types of rudders; the methods of calculating pressures on the surface and the area of surface of the rudder for different types of ships; the turning motion of a ship and the methods of conducting turning trials. The lectures of the year conclude with a practical series on ship yards, which explain the steps for the foundation, organization and arrangement of offices, building yards, docks, machine shops, sheds and railway connections. The drawing room work of this year requires that the students, in groups of two or three, prepare sets of working drawings and perform the necessary calculations for a vessel, which is outlined and specified by an instructor.

In the third or final year the entire time is devoted to naval architecture, the lectures are on the practical subject of the processes of shipbuilding and are divided into the work of the office and that of the yard. The former includes explanations of the duties of the scientific department, the preparation of specifications, the preliminary design, the collection and arrangement of data, work of the drawing office and mold loft and the ordering of material. The latter or yard work includes

the organization of workmen and the duties of the different classes; the arrangement of the keel blocks and staging, the work in the tool sheds, erection of parts on the blocks, laying of wood decks and joiner shop work, plumbing and smith work, shipping of engines and boilers, rigging and finishing, the methods of launching and the associated calculations and the arrangements for trial trips and use of resulting data. In the drawing room each student must prepare complete plans of an original design and compose in English a thesis on some subject in the field of naval architecture.

During the three years of the course each student must spend some eight months at practical work in one of the seventy-odd ship yards of Japan, all of which are open to the University students. This time is made up during the first and second summer vacations and the four months of the first term of the last year. By special arrangement with the ship yard management all students performing this part of the course are allowed to choose the department of the yard in which they are to work, while their industry and application at the yards are carefully guided and watched by the instructors and reported to the University to be counted in the student's class standing. For graduation a student is required to attain an average of 60 per cent on a possible 100 per cent for each of the years, and at least 50 per cent in each study. Failing in this he is allowed to enter for the year's work a second and a third time, but on failing in these he is dismissed from the University, to make room for more intelligent applicants. In the year just passed there were sixty-six graduates from the class in Naval Architecture. Of this number twenty-one entered the Japanese Naval Construction Corps, thirteen became surveyors for the Japanese Marine Bureau, while the remainder are professionally employed in some private capacity.

There are six instructors in this Department, three professors, two assistant professors and one special lecturer. As each of these has certain branches to which he confines his instruction and study an exceptionally high point of efficiency is gained for the whole course. The senior professor has, in addition to the general supervision, charge of the instruction in the practical shipbuilding of the third year and the subjects of propulsion and resistance. The senior professor's chief colleague is a Scotchman, a graduate of Glasgow University, and at present the only foreigner on the staff, who gives instruction in the subjects of waves and rolling, steering, vibration of ships and topics of practical shipbuilding. The third professor has the subject of strength and design of merchant ships, while the lecturer, a Captain Constructor of the Imperial Navy, has charge of warship design. The two assistant professors have the lectures and directions concerning stability work and laying off. The senior professor, Mr. Shinrokuro Miyoshi, on graduating from the Engineering College in 1879, was sent by his government to study shipbuilding in England, where he entered an apprenticeship at the ship yard of Napier & Sons, Glasgow, and at the same time studied at the University in that city. On returning to Japan three years later he was appointed an assistant professor of naval architecture at the Engineering College, from which he has advanced to his present office. In addition to his professorship Mr. Miyoshi is the Inspector General of the Department of Communications of the Government Bureau of the Marine, where his energy and introduction of scientific principles have won him a high civil decoration from the present Mikado.

The present position of Japan, whose recent and continued growth in shipping and shipbuilding requires men trained and experienced in scientific thinking and working, has caused the development of the Naval Architecture Department of the University from its conservative English basis to its present broad minded union of theoretical and practical training. The high merits of the practical training and the attention given to the application of the theoretical work to actual shipbuilding are the features which give a graduate of the Department a position of responsibility in the profession immediately on completing the course, whereas, the conventional school of naval architecture graduates a student to an apprenticeship in a yard, or, possibly, if he has acquired some skill in handling a drawing pen, as an assistant draftsman. This training, if applied with the remarkable industry that the Japanese have shown in other lines, will develop the merchant shipbuilding of Japan to a rank with that of England and Germany.

This course, or more particularly the naval architecture classes themselves, could be followed electively with the highest profit by any English speaking student interested in the Japanese language, as, on its satisfactory completion, he would be able to enter a remunerative professional position. This is especially the case in a country where modern shipbuilding is in a state of development, and where there is an immediate need of men, as is the case in Japan. This attendance by a foreign student is wholly feasible, as the Department, though nearly to its limit of numbers each year, would show every courtesy to a foreign student, and if entering as an elective student the examinations would be little more than nominal. The tuition fees per session stand at $12.50 for all the classes of the course or but for a single class; and for the additional sum of $5.00 per year the use of drawing instruments, all paper, pencils and supplies are given to the student; while the expenses of moderate living in Tokyo can be easily brought to $25.00 per month.

The future of the College of Engineering and in particular the Department of Naval Architecture is one of the highest possibilities. The deep interest in shipbuilding throughout the country reflects on the College, and shipbuilders freely present drawings, data, etc., for the benefit of the school. The plans of the administration, supported by the interest of the Mikado, contemplate extensions to the possession of an independent building supplied with the most modern improvements and experimental equipment in order that the name of the University may stand high among the naval architecture schools of the world, and that the Japanese may be given opportunity to gain such training as shall enable them to place the shipbuilding of the country on an equal with the finest in the world.

The American Liner *St. Paul* has been making exceptionally good time since she left Wm. Cramp & Sons Shipyard, where her engines were extensively overhauled.

MARINE ENGINEERING

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

THE present condition of the torpedo boat destroyers authorized by act of Congress May 4, 1898, and contracted for during that year furnishes an instructive instance of the reaction of trade and industrial relations upon an attempt to embark on a large scale in special high grade work, in some cases without suitable preparations as to plant and shipyard personnel. Of these destroyers contracted for nearly three years ago, none is yet ready for final acceptance, and a prophet of rare insight indeed would be required to foretell when the last will be ready for actual service. It should not be understood, however, that the only, or perhaps, even the chief reason for this long delay is to be found in the incapacity of the builders. The difficulty in obtaining structural material from the rolling mills must also take a large or even a major share in the responsibility for the delay. It is, of course, true that in several cases these boats were taken by yards newly organized, or even just starting in the shipbuilding work, and with a staff and personnel necessarily without any considerable experience with work of this character. Under these circumstances it is only to be expected as an inevitable consequence that many unforeseen difficulties would arise and much time elapse before staff, personnel and equipment could be brought into a condition necessary for most efficiently carrying forward naval construction of this type, the very acme of the shipbuilder's and marine engineer's art. Doubtless much of the delay can be traced to this general cause, a delay for which the shipbuilder must not be too strongly blamed.

A general study of the whole situation, however, seems to indicate that a more potent cause for the slow progress is found in the repeated and lengthened delays in receiving structural material from the mills. Structural material for torpedo boat destroyers is small in amount, of the very highest grade and hence requiring the most special care in manufacture, and is furthermore subject to the most rigid and exacting inspection on the part of the Government inspectors. There is, therefore, but small object on the part of the rolling mills to put themselves out in order to accommodate the needs of the builder of vessels of this type.

Indeed, it has appeared from statements made by the builders in connection with appeals to the Navy Department for an extension of time, that they are able to obtain no guarantees from the mills as to delivery of material, and in fact that their requests for such supplies receive but slight consideration at the hands of the producers and that protests avail nothing. All this simply means, of course, that the producers have matters in their own hands, and that they have been overstocked with orders for material of a more profitable character than that required for torpedo boats, and that in consequence they propose to suit their own convenience in the matter of the making and delivery of such material.

In the meantime the Government is suffering the delay, various extensions of time have been granted to the builders, and it is likely that still further extensions will be asked and allowed.

The apparent readiness with which these extensions have been granted until sufficient time has elapsed in which to build even a battleship seems to indicate that the Navy Department considers the explanations made by the builders as satisfactory and does not, therefore, wish to hold them directly responsible.

Wherever the blame may lie, however, it is a shameful condition when work of this character may be held up as this has been, due to a state of affairs which, to say the least, is only in small part really necessary.

WE publish on another page from a contributor, an article on the steam jacket and its use as an aid to the economy of the steam engine. Supplementing the discussion of the subject as given by the author, the reason for the diversity of result should be, perhaps, somewhat more clearly pointed out. This may be viewed from two standpoints. We may simply note the fact that the steam jacket is a consumer of steam and that this expense must be balanced off against whatever saving may be effected, and that the operation thus involves the balancing of one loss against another. Or otherwise we may consider that the use of a steam jacket is simply one way of introducing heat into the engine and therefore into the working cycle of the substance in the engine cylinders. The question of economy will then turn on whether it is more advantageous to introduce the heat direct by putting all the steam used into the cylinders, or to put part of the steam into the cylinders and introduce the remainder of the heat from a jacket through the cylinder wall.

As the author points out, the great purpose of the jacket is to decrease cylinder condensation, and however we may view its action it amounts in the end to the substitution of a loss in the jacket for another loss in the cylinders; or to the introduction of one loss to save another.

The final result will clearly depend on the relation between these two losses, and under varying conditions the balance may turn either way, though, as a rule, the result will show a gain for the jacket.

Mention may also be made of a further point in connection with the conclusion reached by the author that the low pressure cylinder of a multiple expansion condensing engine is the most suitable place for the jacket, or that a jacket is more likely to be beneficial on this cylinder than on the high or intermediate cylinders. This proposition admits of some doubt, and is perhaps hardly in accord with the views usually accepted at the present time. The low pressure cylinder being in communication with the condenser for half of the time it is usually considered that the fitting of a jacket on this cylinder is a most excellent means of transferring heat through from the jacket steam to the condenser without its doing any useful work. This is hardly to be desired, and it is probable that in the opinion of most engineers a steam jacket on the low pressure cylinder is more likely to be a source of net loss than of gain. Still it must be admitted that these questions have not received the experimental examination necessary for a complete statement of the conditions under which jackets will or will not be productive of a gain in economy. In the mean time reheaters between the cylinders of a multiple expansion engine are to some extent taking the place of jackets as a means for adding heat to the steam on its way through the engine, and if in the near future superheated steam shall advance into more common use, the need of the jacket will further decrease in nearly corresponding ratio.

UNDER present commercial conditions it is usually sufficient to point out a possible economy in order to have it taken up with vigor by the business world interested. We are not sure that ship builders and engineers have fully appreciated the advantages to be derived from the standardization of the auxiliary machinery used on shipboard. A particular phase of this question was brought before the American Society of Naval Architects and Marine Engineers at its meeting in November last by Mr. W. D. Forbes, the subject of his paper being the interchangeability of the units commonly employed as marine auxiliaries. Mr. Forbes ably argued the practicability at least of making a good beginning in this direction, and urged strongly in its favor the saving in repairs and the simplification of work in the drawing rooms and shops. It is understood that as a result of the paper and of the discussion which it called forth, a resolution was adopted calling for the appointment of a committee which should take into serious study the possibilities which this proposition involves. Whether such committee has been at work on the question we are not advised, but we may at least hope that the matter will not go by default, and that at the meeting of the Society in November next a report may be presented which shall give us more definite ideas on this subject, both regarding its practicability and regarding the attendant advantages to be expected. In the mean time those who are interested in the subject will find in MARINE ENGINEERING for December, 1900, a reprint of Mr. Forbes' paper, while the paper with full discussion will be found in the last volume of the transactions of the Society. The questions herein presented may be recommended to the careful consideration of all who are interested in ships and shipping, and in the various ways in which economies may be sought, both in first cost and maintenance.

THE CONTEST FOR THE PRIZES.

All articles intended for competition for the two prizes of $15 and $10 each, mentioned in our advertising pages, must be sent in promptly, as the contest will close on December 31.

All articles published will be paid for at the regular rates. The best and the next best will draw the prizes in addition.

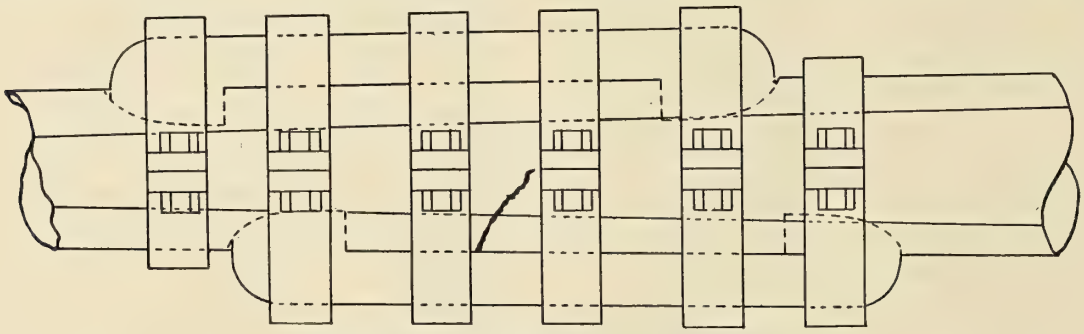
Repairing a Broken Connecting Rod.

One day in early summer of 1898 the S.S. ——— was steaming comfortably along off the Florida coast en route from Havana to New York. About 3 P. M. as the engineer of the watch was making his round he approached the L. P. engine for the purpose of examining the main guides. After assuring himself that they were cool and that everything was working properly, he was about to turn away when his eye was attracted by a peculiar line or crack which seemed to show on the connecting rod. The engine was running only about 70 revolutions so that as the connecting rod swept up and down and to and fro, his eye could follow this line marked out as it was by grease which had worked in. It had all the appearances of a crack and at least to the imagination of the engineer grew continuously longer and wider. Without waiting for further warning the engine was immediately stopped when it was found that his fears were only too well grounded. A deep and serious crack was found running diagonally across the connecting rod about a third of the way from the lower end. It seemed to have started in an original small flaw in the metal and was rapidly extending down into the body of the rod. It is altogether likely that in the next few revolutions it would have gone much deeper still, and shortly have resulted in breaking the rod off short.

No sooner had the engine stopped than the chief appeared on the scene, and after taking account of the situation the following plan for making repairs was adopted and carried out.

A fore and aft view of the rod is shown in the figure. Four notches were then drilled and chipped in the rod as shown. These were in pairs on opposite sides of the rod, but not directly opposite each other, so that the metal taken from any one cross section of the rod was not more than the cross sectional area of one notch. Two large steel bars were then formed up by the blacksmith with ends forged over as shown so that they would fit into the notches. The diameter of the rod was 8 in. and the width of the notches was about one-fourth the diameter of the rod or 2 in., while their length was about three times the width. This gave the necessary section to the bars for taking the pull on the rod with the least practicable loss in the cross breaking strength transversely. Then to bind the bars to the rod and so insure the full transverse strength of the combination, six straps were arranged as shown. The general action of the bars and straps will be clearly shown by the figure and will not require further detailed description. With this arrangement we were able to proceed safely on the trip under somewhat reduced power until we reached New York, when a new rod was fitted.

EDMUND LEAVENWORTH.



METHOD OF REPAIRING BROKEN CONNECTING ROD.

Result of a Key Backing Out.

The following description of a breakdown, while not illustrative of any difficult problem in making repairs, may serve as a good example of that attention to even the smallest details which is so necessary in the care and manipulation of a marine engine. In June, 1900, a Government vessel was detailed to convoy a steam barge from Hampton Roads to Havana. The barge was fitted with sufficient power to propel her at a speed of about six knots an hour. In order to hasten the voyage as much as possible it was decided to let the barge steam, and at the same time give her a line from the convoying steamer. The resultant speed of both vessels was about nine or ten knots an hour. A system of signals on the whistle was arranged between the two vessels to guard against a collision in case of a breakdown.

During the mid-watch on the first night out, with the main engine making about 125 revolutions per minute, the engineer on watch heard the sharp click of something falling on the floor plates in the lower engine room which was immediately followed by a succession of terrific thumps making the vessel tremble from stem to stern. Rushing to the vicinity from which the sound emanated he saw the low pressure links oscillating from side to side at a great speed. On the go-ahead side the reversing arm was striking at each oscillation against the working platform and on the backing side was running out until the stud between the links struck against the link block. He quickly ran to the throttle and shut off the steam. After the

engine had stopped and while he was searching for the cause of the trouble, there came a crash which nearly took every one off his feet. This was quickly followed by another crash of less severity. The cause of this state of affairs can well be understood after a perusal of the following.

The engine of the towing vessel was of the ordinary vertical triple expansion type, capable of developing about 2,500 I. H. P. The reversing shaft ran along the front of the engine and was supported by brackets bolted to the bottoms of the cylinders. The low pressure reversing arm was keyed to the after end of the reversing shaft. The ship on this occasion was well out at sea, and it was decided to shut off the steam from the reversing engine in order to lessen the heat in the engine room. This caused an increase in the slotting motion of the links and a consequently greater vibration of the valve gear. The result was that the key securing the reversing arm to the shaft had worked out, although having been in place for over two years. The reversing arm thus being loose on the reversing shaft allowed the links to slap back and forth with the results above stated. To hook a chain tackle on the end of the links, haul them over to the proper position and drive the key back to its place was a matter of but very few moments. The expensive part of this mishap was the damage on deck. When the engine was shut down, the officer of the deck blew the proper signals for the barge to stop its engine. A green man was on watch on the barge and he stepped into the pilot house to see what the signals meant. Before he had fully made up his mind as to their meaning, the barge struck the steamer on the starboard quarter, bounded back and struck her again a little further forward. The first blow struck the Franklin life preserver, which was carried away with all its gearing, and as the light was instantly started off, it could be seen floating away to the leeward. The plates were badly dented in on the steamer and the barge's bow was smashed in. The necessary repairs to both vessels amounted to a considerable sum, all of which was directly due to the backing out of a key that had been in place for over two years.

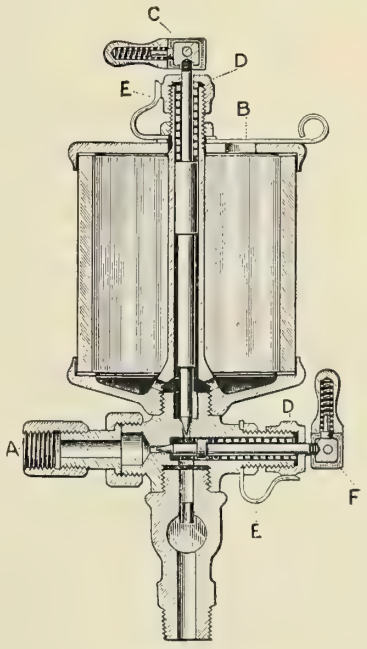
ALLEN MAC.

WIRELESS TELEGRAPHY.—The wireless telegraphy installation between Borkum and the Borkum Riff Lightship on the North Sea, which was put to work on May 15, 1900, transmitted 655 telegrams up to December 31 last—a total of 8,040 words. The service has from the beginning given satisfactory results on the whole. Although the installation is almost exclusively employed between the two posts mentioned, it is interesting to note that appreciable results have been obtained with the steamer *Kaiser Wilhelm der Grosse*. The steamer succeeded in exchanging messages with the lightship with perfect ease at a distance of 50 miles. During summer the working of the installation suffered little from lightning disturbances. The most prolonged disturbances were during autumn and winter, and were caused by damages to the masts and yards of the lightship on which the receivers were fixed. These instruments are worked, not by professional telegraphists, but by the ordinary lightship crew, who have been instructed in their use.

ENGINEERING SPECIALTIES.

Pressure Oil Cup.

The pattern of pressure oil cup herein shown is claimed to contain certain improvements over other forms of cups used on pressure oiling systems. In such forms the glass cylinder or reservoir must constantly be kept under pressure, and in case of breakage of same, considerable oil is lost and the cup is rendered useless. In the form of cup here shown the glass reservoir is not under any pressure whatever, but, instead, the oil supply is piped through the union *A* in the base, the opening of which into the oil duct leading to the bearing is controlled by the oil regulating valve *F*. The auxiliary supply is regulated by the oil valve *C*. With



LUNKENHEIMER OIL CUP.

this form of cup it is easy to regulate the supply of oil under pressure, and when it is desirable to cut off the same, the valve *F* can be turned down and will act as an indicator, showing from a distance that the supply is shut off. The regulation of this valve is simple and easily affected, and, when once set, is not disturbed by the jarring of the machinery. The feed can be turned on or off by simply raising or lowering the cam lever *F*. The sight feed in the base is large, and the falling drops of oil can be seen plainly from a distance. The auxiliary oiler (which is intended to be used in case the pressure supply should be discontinued or cut off) consists of a standard pattern oil cup, the feeding of oil being regulated by the cam lever *C* in the same manner as with pressure supply. The auxiliary oiler has a large slide filler *B*, which dispenses with the screw plugs used in other patterns.

This oil cup is put on the market by the Lunkenheimer Company, of Cincinnati, Ohio.

The Clarke Automatic Coaling and Weighing Barge.

The accompanying cut is intended to illustrate a new and improved method of coaling steamships which has been in successful operation for the past year in the vicinity of New York harbor by the Automatic Coaling and Weighing Barge Company, No. 71 Broadway, New York city. The automatic barge is designed to effect a revolution in the old fashioned method of coaling steamers, which consists in shoveling into buckets the coal contained in a barge lying alongside, elevating these buckets by means of one of the steamer's winches, and dumping them into the bunker where the coal is stowed by trimmers. By the new method the coal is contained in a steel barge of 1,000 gross tons capacity, divided by transverse bulkheads into several compartments or coal bins. The floor of each bin is raised above the bottom of the barge, to accommodate a passageway which runs the whole length of the bins, just above the keel, and in which a train of buckets is drawn by an endless chain composed of flat steel links. There are three square openings in the bottom of each bin, closed by sliding doors, and, as each hole is opened, the coal, lying above it, slides down into the buckets. The train of buckets is moved by means of a steam engine in the rear compartment of the barge, through the horizontal passageway, then vertically upwards in a tower, then again horizontally to a scale house at the top of the tower, which contains two automatic weighing and recording scales, into one of which each alternate bucket is dumped. The coal then slides from the scales into two telescopic steel tubes, which deliver it into the bunkers of the steamer. The principle of the coaling barge is therefore similar to that of the well known floating grain elevator, but the machinery is much heavier, and contains many devices to facilitate the handling of a somewhat intractable material like coal. The barge delivers the coal steadily at the rate of 125 gross tons per hour, and has been operated for several hours at a time at a rate of 135 tons. The whole operation is almost noiseless and free from dust, and it is accomplished entirely by he machinery of the barge, without any hand labor, and without the assistance of any of the machinery or crew of the steamer. The total crew of the barge, including captain, engineer, fireman and cook, is only six men.

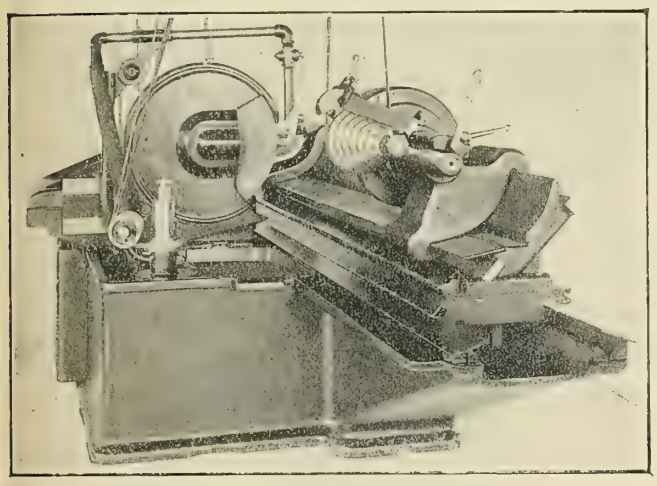
CLARKE BARGE FOR AUTOMATICALLY COALING VESSELS.

The Norton Grinding Machines.

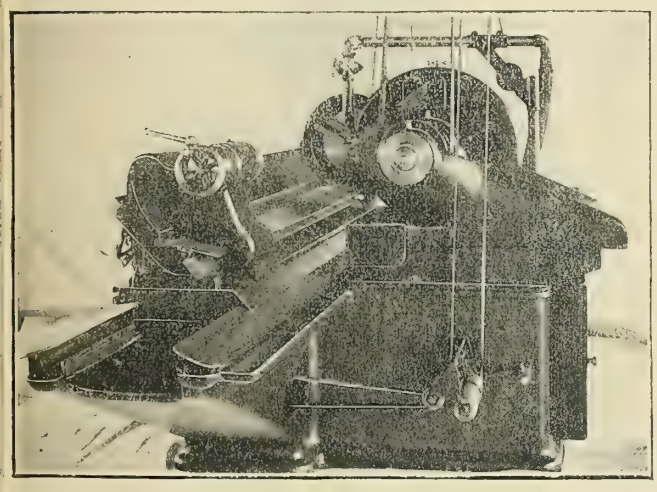
The grinding of cylindrical work has sometimes been considered a refinement that could not be afforded on ordinary work and was only for special cases where expense was no object.

In the machine here shown, Mr. C. H. Norton has embodied the results of his years of experience in grinding, and has produced a machine which promises to materially alter the economical status of the grinding machine. A 24 in. wheel of 2 in. face is mounted in heavy bearings on a heavier head, which moves to or from the work for various diameters. In consequence, the wheel will not spring away from the work

and the cutting particles will do their work without chance of escape except by crushing. The work is supported by follower rests, which also carry supports underneath, thus holding it rigid. This combination of rigidity in every part is the main reason for the excellent results which are obtained. It is not proposed, with the grinder to compete with the lathe in the roughing out of work, but rather to take cylindrical



LEFT HAND END OF MACHINE.

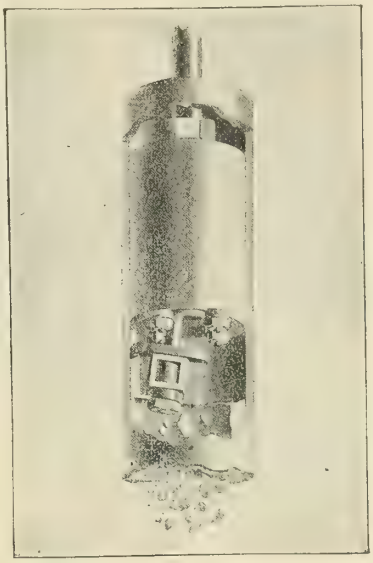


RIGHT HAND END OF NORTON GRINDING MACHINE.

work from the lathe after the roughing cut and finish it in less time than can be done in the lathe, at the same time giving a perfectly round piece of work. To illustrate the capacity of such machines, we give the results of a few of their many grinding jobs sent in by outside parties. A soft steel shaft, 6 ft. long, having seven diameters, the largest of which was 4 1-2 in., was ground in 2 hr. 25 min., the limit of error being .001 in. The average amount of stock ground from the diameter was 5-64 in. A plain shaft, 4 in. dia., 3 ft. long, turned rough to 12 pitch, bottom of feed lines .010 in. above size, was ground in 6 min.; .025 in. was removed from this shaft in 10 min. A plain shaft, 2 1-2 in. dia., 4 ft. 6 in. long, rough turned to 8 pitch, bottom of feed lines .008 in. above size, was ground in 8 min. A plain shaft, length 8 ft., dia. 21-4 in., was ground from the rough to 2 5-32 in. dia. in 3 hrs. If it had been turned first roughly in the lathe (say 12 pitch), time of grinding would have been 1 hr. The greatest variation in this shaft was one-half of one-thousandth of an inch over the entire length. The capacity of this machine is up to 8 ft. in length, 8 ft. 6 in. in case of piston rods, with a swing of 18 in. dia. Tapers up to 2 in. to the foot may be ground if desired. All the changes of speed and adjustments are provided that years of experience have found desirable. This machine is manufactured by the Norton Grinding Company, Worcester, Mass.

The Dean Boiler Tube Cleaner.

One of the difficult problems which confronts engineers in charge of steam boilers, and which causes



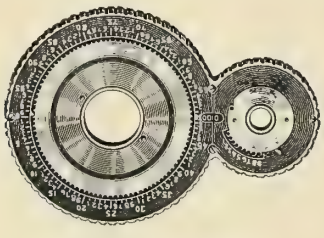
MACHINE FOR CLEANING BOILER TUBES.

them no little thought, is how to get rid of scale formation on boiler tubes. All water, except distilled water, holds in suspension, more or less, foreign matter which is precipitated as soon as the water is converted into steam, and forms a hard scale deposit of a nonconducting property injurious and wasteful, in the generation of steam. The shells of boilers and their tubes will, if prompt and efficient remedies are not taken, become coated to such an extent that firing is made more and more irksome and the consumption of fuel unduly increased. In ordinary return tubular boilers the scale forms on the outside of the tubes, and in water tube boilers the scale forms on the inside of the tubes. In the former the tubes are so close to each other that it is a difficult and heretofore impossible task to clean off the whole exterior surface. One of the most efficient machines for removing the scale from the tubes of both types of boilers is the Dean Boiler Tube Cleaner, manufactured by the William B. Pierce Co., of Buffalo, N. Y. The Cleaner is practically a miniature engine operated by compressed air or steam. At the end of what would

be the piston rod on a large engine is a small iron hammer, or vibrator, made with the same curve as the tube. Having been connected by means of a hose with an adjacent boiler or air compressor the machine is introduced at the front end of the boiler tubes to be cleaned, and the power is turned on. The hammer commences its oscillating movement, increasing its strokes rapidly to about 800 to 1,000 per minute, while the accumulation of soot and soot crust is removed and blown out by small jets of exhaust steam or air. In itself this is a valuable feature, yet, a minor consideration compared with the more important results of the dislodging the scale. There are two ways to remove thick, hard scale from the tubes in a water tube boiler: either to bore it out by some device that has a circular movement, or to give the scale a direct blow to cut and loosen it from the tubes. In the former case great power is required which is difficult to apply in a tube of 3 1-2 or 4 in. diameter. In the latter case, the work is very much simpler and does not involve the use of such great power. For water tube boilers the hammer on this cleaner is changed to carry a head which is made sharp to cut and shatter the scale, yet so guarded that when the scale is removed and the boiler tube is clean, the sharp edge cannot reach the iron itself or make the slightest indentation in the tube. The vibration, meanwhile, serves also to remove any soot formation on the outside of the tube. The machine is simplicity itself and the company furnishes printed instructions for installing and operating. The illustration here given is of this type of machine. For operation in water tube boilers the company also manufactures an ingenious feeding device to work and revolve the cleaner through the tube. This feeding device is not necessary, but merely an adjunct which lightens the manual labor on the part of the operator.

The Lightning Calculator.

Mechanical devices for reducing to a minimum the expenditure of energy of the accountant, are widely used. One of the most successful is here illustrated. This instrument is of great assistance to the bookkeeper, clerk, manufacturer and business man, and its



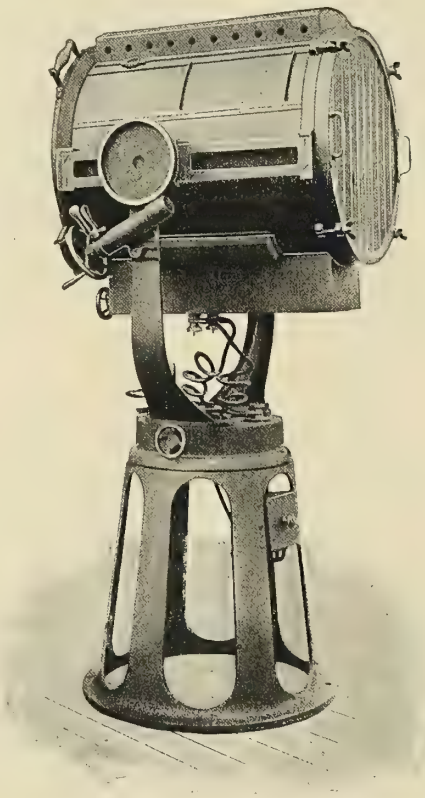
SIMPLE ADDING MACHINE.

use has been applied to such varied operations as stock taking, ore checking, surveying, lumber tallying, etc. The "Adder" will add any number of columns of figures, one, two or three columns at a time, with perfect accuracy and great rapidity. The Bookkeeper Publishing Co., Detroit, Mich., will furnish further information to those who may be interested.

Search Lights for the Navy.

The accompanying illustration shows one of the latest Navy type hand controlled projectors which is being furnished to a number of the new destroyers and cruisers. This particular illustration is taken from an 18 in. projector, but the 24 in. and 30 in. are identical in design and style of construction.

The specifications for the Navy require a much better projector than is necessary for ordinary commercial use. No iron or steel is used in the construction unless absolutely necessary, such as for magnet cores, etc., where no other material would answer. The carbon feeding mechanism must be capable of working



CARLISLE & FINCH SEARCH LIGHT.

in any position and of feeding the carbons the entire length without any apparent difference in the voltage across the arc. The cylinder on the barrel of the projector must be capable of rapid rotation by hand or gradual rotation by means of gearing. A vertical elevation of 70 degrees above the horizontal and 30 degrees below the horizontal is required. Added to these requirements, the entire projector must be constructed in the best possible manner and be absolutely reliable in its every part.

The projector shown is required to pick out a white object 10 ft. by 20 ft. at a distance of 4,000 yd. The larger projectors must show the same object at distances of 5,000 and 6,000 yd. respectively. Either parabolic or Mangin mirrors may be used, and the projector is so constructed that either can be inserted in a few minutes. In case of an attack by torpedo boats the light would be used at close range and is required to cover as great an area as possible. To do

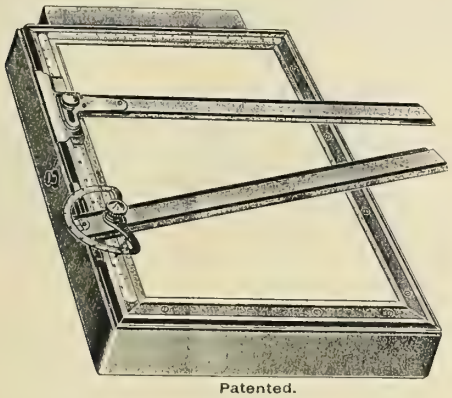
this a special front cover is supplied which is fitted with a set of dispersion lenses. These lenses spread the light out horizontally, but not vertically, so that the water is illuminated for a wide range.

The mechanism for transmitting vertical motion to the cylinder consists of a worm and worm wheel which may be thrown in or out of mesh like the back gear of a lathe. The trunnions for supporting the cylinder are also adjustable. This projector is manufactured by the Carlisle & Finch Co., of Cincinnati, who have established a wide reputation as manufacturers of search lights. They manufacture also a line of search lights for all classes of seagoing and river steamers, and while not so expensive nor complicated as the Navy standard projectors, are nevertheless fitted with the same carbon feeding mechanism and the same high grade mirrors.

A beautifully finished 9 in. dia. projector is made for yachts and launches. The commercial type projectors are finished in dead black brass, polished brass or white enameled iron, according to the wishes of the purchaser.

A Handy Drawing Outfit.

The drawing outfit shown in the accompanying cut consists of a strongly made mahogany case mounted with German silver, on which the T square slides and with grooves for the scales, which are placed on

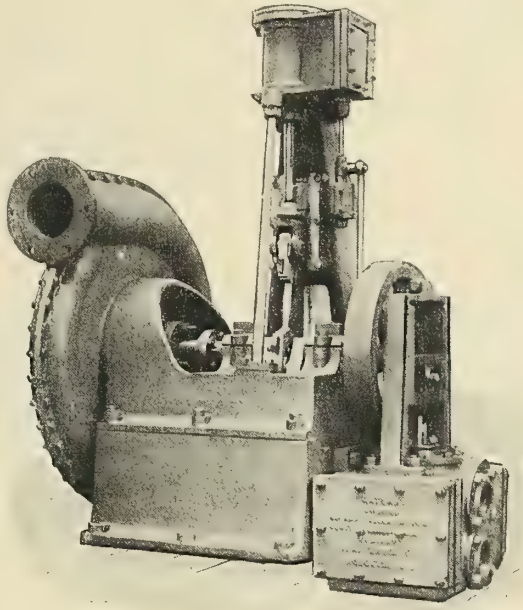


DRAWING OUTFIT.

two sides of the oufit. The paper is held firmly in position by springs which press up against overhanging edges of the German silver guides and can be put in position or removed in an instant. No pins or other fastenings are necessary. Measurements are obtained by simply sliding the T square to the desired point. This outfit will take either pads or single sheets of paper and is provided also with a drawer for T squares and other necessary articles. The T squares have brass heads nickel plated and boxwood blades. These outfits are made in two sizes, one for paper, 10 in. by 15 in., and one for 15 in. by 20 in. They are neat in appearance, always ready for use and will be found a great convenience in the office or on shipboard. They are manufactured by J. and G. Rich, of Philadelphia, Pa.

Waters' Air and Circulating Pump.

A combined air and circulating pump, recently placed upon the market, will doubtless meet with favor among marine engineers. As seen in the accompanying illustration it fulfils the requirements of lightness and compactness, with all parts of easy access. A simple engine, such as is used for running a circulating pump, runs both the centrifugal and air pumps, the latter being mounted to the right of the engine base. The machine is in daily operation to demonstrate that an air pump can run efficiently at the same number of revolutions as the circulator, and that a good vacuum may be maintained. There are six rubber, brass-seated suction valves at the bottom and the same number of discharge valves at the top of the valve box, and all can be taken



COMBINED AIR AND CIRCULATING PUMP.

out or repaired by removing the bonnets at front and rear. At 100 rev. of this 5 in. by 5 in. engine, 400 horse power can be taken care of by the pumps. Those who may be interested to learn further particulars or witness this efficient auxiliary in operation, should communicate with F. A. Verdon, Hoboken, N. J.

Electrolysis and Other Defects Inherent in Condenser Tubes.

Owners and officers of vessels having surface condensers recognize the value of having condenser tubes that will neither corrode nor split. Defective condenser tubes will impair the vacuum produced by the air pump and lower the temperature of the feed water by mingling condensing water with the condensed steam, and by this cause, where salt water is used as the cooling medium, cause incrustation, in amount according to the extent of leakage between the salt and fresh water sides of the condenser.

The softer the tube can be made and not sag too much between the supporting plates and condenser

heads and also be reasonably free from liability to injury in handling and transportation, the less the liability to longitudinal fracture from internal stresses, inherent in their manufacture, and produced by sudden changes in the temperature.

Copper is hypothetically the best metal from which a condenser tube can be made. Acting on this hypothesis the French Admiralty fitted out the condensers of the battleship *Brennus* with copper tubes, but it was soon found that they corroded even more rapidly than brass.

On account of this inherent defect and the lower price of brass, tubes made of the latter have been used almost entirely in condensers. The sizes usually employed for condensers are 5-8 in., 3-4 in. and 1 in. outside diam., number 18 Birmingham wire gauge (about 1-20 in. thick), and running in length up to 12 ft.

During the past five years very successful tests have been made with an alloy of copper and nickel, known as "Benedict-Nickel," and having passed the experimental stage, owners and engineers in charge of condensers are assured that at least all the serious defects of copper and brass tubes, due to electrolysis and splitting, are overcome, and that a practically indestructible tube is on the market.

The color of this alloy is white throughout, substantially the same as pure nickel.

The following test, made at the U. S. Arsenal at Watertown, Mass., shows its tensile and bursting strength:

Outside Diam.	Thickness B. W. G.	Tensile St.	Bursting St.
5-8 in.	20	78 530	10,170
5-8 in.	18	74.010	13,130
1 in.	18	76,310	7,870

For comparison, a test made on brass condenser tubes, is here shown:

Outside Diam.	Thickness B. W. G.	Tensile St.	Bursting St.
5-8 in.	18	50,900	6,300

"Benedict-Nickel" tubing will not crack, as it is not readily affected by extreme heat and cold, and is free from all imperfections liable to produce fractures.

This is due to a peculiar property which they have over all other tubes, that no matter how many times they may be redrawn without annealing, no internal stresses are produced that ultimately result in longitudinal fracture.

The most vexatious and serious trouble with condenser tubes afloat, and even ashore, is corrosion, due to electrolysis.

To account for this peculiar action and condition observed in condenser tubes that have been in use for a period of time, the only explanation that can be suggested involves electro-chemical action as a pronounced feature. To arrive at a proper understanding of the nature of this action a few explanations must be given.

The elements used in tube alloys may be arranged according to their electro-chemical character, so that each element, as arranged in the following table, will be positive to any element placed above it, and negative to any one below it. The nearer any two are together, the less the difference in electric potential, thus:

Copper.
Tin.
Lead.
Nickel.
Zinc.

The meaning of this is shown by the common galvanic cell used in telegraphy. Copper and zinc are immersed in a solution, the current flows through the liquid in the cell from the zinc to the copper and is called the positive current, and, under such conditions, the zinc is said to be positive with reference to the copper, as the above table shows. Other metals besides zinc and copper exhibit more or less similar electrical phenomena.

The metals used in making alloys for tubes are at a different electric potential, in consequence of this electro-chemical relation of metals when in contact with an exciting liquid, such as impure fresh or sea water.

By the term electric potential is meant the power of doing electric work.

It is necessary for the reader to bear in mind two well-known facts: first, that deterioration in an alloy proceeds at the expense of the electro-positive element; second, that oxides of metals are electro-positive to their own element.

On account of their difference in electric potential, a flow of electricity is set up, and metals forming the alloy are chemically changed.

These chemical changes can be accelerated or retarded by the nature of the liquid with which the tubes are in contact. This is shown by the well-known fact that steamers, tugs and yachts, used mostly for harbor duty, are unable to keep a set of condenser tubes in use very long, on account of the water being contaminated by sewage and other substances that afford a good exciting medium.

In the harbors of many large cities such craft have abandoned the use of copper and brass tubes in surface condensers almost entirely.

Electrolysis seems to have been aggravated by the installation of electric lighting plants in vessels with metal hulls, due possibly to stray real or induced currents, that go to reinforce those that are always operating in a milder form between the alloys of the metals in contact with the water inside of the condensers. It is here proposed to show why copper and brass tubes corrode inside of a condenser, and why "Benedict-Nickel" does not.

In a commercially pure copper tube it is impossible to cast the billet, or shell, from which the tube is subsequently made, without oxidation appearing in the metal, either visibly to the naked eye or microscopically.

The surfaces of all these minute holes are covered with copper oxide, and this oxide and its mother element are particularly active from an electro-chemical standpoint.

When the tube is made from this stock, the pits, or holes, covered with oxide, are drawn into minute longitudinal seams, laminations or flakes permeating the structure, and which, in only a few instances, can be detected. Electro-chemical action is set up where the oxide and copper are associated, and after a while

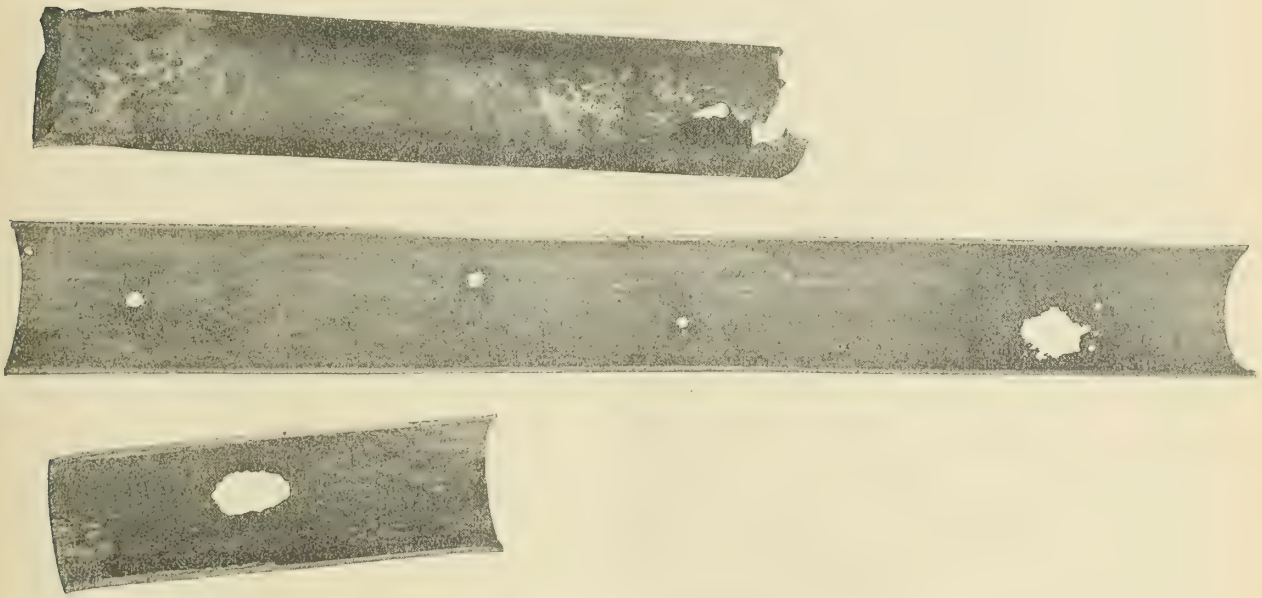
a discoloration can be noticed, which gradually is formed into a pit or cavity. Often in an ingot there are only a few such defects, and when manufactured into a tube these bad spots will be widely separated, often causing wonder why the greater part of the tube is in good condition, and the evidence of electrolytic deterioration is localized at widely separated places.

A brass tube is made from an alloy of copper and zinc, the two most widely separate metals in the given electro-chemical scale. Zinc, naturally a very unstaple element, is electro-positive to copper, and when the conditions are right rapid corrosion takes place, the zinc often disappearing entirely from the tube, leaving a rotten formation of a dull brown color, that has but little strength. Holes frequently are formed in the tube and other demonstrations of electrolysis are apparent.

It has been shown by this article why, theoretically, copper and alloys of copper, other than "Benedict-Nickel" corrode, and why the latter does not. It is also proven that "Benedict-Nickel" does not corrode from the fact that condenser tubes of this metal have been in constant use for several years on transatlantic liners, men-of-war and yachts, and on examination have been found to be as good as new; whereas, brass or copper tubes alongside of them, or for which they were substituted, were found to be worthless.

In regard to the relative first cost of "Benedict-Nickel," copper and brass condenser tubes, brass is the cheaper, "Benedict-Nickel" costing about two and a half times as much, on account of the high price of nickel and greater cost of manufacture.

This difference in price is unimportant when it is known that the life of a "Benedict-Nickel" condenser tube is indefinitely long; whereas, brass and copper have frequently to be renewed.



SAMPLES OF ORDINARY CONDENSER TUBES, SHOWING RESULTS OF PITTING.

In the "Benedict-Nickel" condenser tube, copper is alloyed with the universally recognized inert element nickel, which is acknowledged as comparatively free from corrosion, as experience has shown in its use for plating other metals, and as a non-corrosive component of many steam and water appliances.

Nickel, on account of its inert properties, and its close proximity to copper on the electro-chemical scale, makes the ideal metal to alloy with this material.

In looking at the list of elements arranged near the middle of this article, the reader might say, why not use tin or lead, instead of nickel or zinc, for an alloy with copper; as the list shows that they are closer to gether on the scale, and consequently would show less galvanic action?

The reason for not using tin or lead is, that unless used in small proportions, these metals in copper alloys cause the tube to be hard and brittle, and are practically prohibitive in the manufacture of tubing. Discarding, then, tin, lead and zinc, nickel alone on the list remains as the best adapted for the work.

Cost alone should not be considered when the efficiency of a condenser is in jeopardy at all times from tubes unsuited to the conditions under which they may be operating. In some condensers brass will last longer than in others, but "Benedict-Nickel" will last indefinitely long in all situations and under all conditions of water and local action, due to peculiarities of construction or peculiar conditions of hull and arrangement of engines and dynamos.

Canadian Coast Survey Steamer.—The Minister of Marine and Fisheries has advertised for bids on a twin screw steel steamer for Atlantic coast survey and lighthouse service. Her moulded dimensions are: Length, 210 ft.; beam, 34 ft.; depth, 18 ft. She is to be built with six water tight bulkheads and water bottom. As the vessel is to be used for cable repairing and laying, she will have a special cable tank forward and gear for hauling in and paying out cable.

FAULTS IN DYNAMOS.

BY LAMAR LYNDON.

Faults in dynamos may be classified as (*a*) Mechanical, (*b*) Magnetic, and (*c*) Electrical, the last being the most prolific source of trouble. The chief irregularities to which a dynamo is subject are:

a—Failure to excite.
b—Sparking at the brushes.
c—Excessive heating.
d—Irregularity of voltage.
e—Excessive noise or vibration.

Each of these will be discussed, giving the causes and remedies therefor. In order, however, to keep the subject within such limits as may prove instructive to the marine engineer, constant potential, shunt or compound wound, direct current, low voltage machines only will be considered.

Failure to Excite:

The causes of this are: (1) Loss of residual magnetism. This sometimes occurs with small machines, the field magnets of which are of soft iron or steel, where they have been subjected to shocks and jars in transportation or erection. The remedy for this is to excite the field by means of a battery or other source of current. This trouble seldom occurs except in cases of starting new machines, and being once under operation, the magnetism will not again be lost, unless one set of brushes is lifted off the commutator while the machine is operating or the field circuit be opened. The opening of the field circuit when current is flowing, causes an inductive E. M. F. in such a direction as to tend to demagnetize the field, and in some cases, may actually cause:

(2) Reversal of magnetism. When the magnetism is reversed the dynamo can only be made to excite by magnetizing the fields in the proper direction with the battery, or by reversing the shunt field connection. If the latter remedy be adopted, the polarity of the brushes is reversed. This makes no difference whatever in the operation of the dynamo unless it be run in parallel with another dynamo or is connected to a storage battery. If operated with either of these, the connections with them must be reversed.

(3) Open circuit. Open circuits may occur in the armature, at the brushes, in the fields, and frequently in the connection from the fields to the rheostat. An ordinary test with the galvanometer or magneto will show whether a circuit is opened or closed. Often breaks occur in the wire and the insulation remains perfectly good, and in such cases it is impossible to locate a defect by inspection, and it can only be found by means of the instruments mentioned. Frequently, bits of paper, dirt and other nonconducting substances will get between the commutator and the brush tips, and adhere to the latter: or oil may get on the brushes, forming a nonconducting film. The remedy, of course, is to clean the commutator, brushes and brush holders. Open circuits also occur from shellac, oil, or strands of insulation getting between the surfaces of contact at the terminals. Generally this trouble will be found at the brushes or at the contacts. Occasionally, the leading in wire to the field magnet windings becomes broken —usually just inside the flange on the spool.

(4) Brushes improperly adjusted. This fault so seldom occurs and the remedy is so simple, that it is not worth while to discuss it.

(5) Incorrect connections. This fault occurs only in new machines or those which have been taken apart for repairs and afterwards reassembled. The commonest form of incorrect connection is that in which the field coils are so connected as to act in opposition. It is seldom possible to determine the direction in which a field coil is wound and therefore some form of test is generally resorted to. A simple one is to excite the field magnets from any source of current, the armature being removed. An ordinary compass held in front of each pole tip will indicate the direction of the lines of force, emanating therefrom, by attracting or repelling the north end of the needle. The lines of force from any pole should flow in a direction opposite to that of the next succeeding pole. If two adjacent poles are found which send their lines of force in the same direction, one of them is wrongly connected.

(6) Short circuits or heavy load on external circuit. This in reality is not a dynamo fault, but with shunt machines, failure to excite will often be found attributable to this cause. If the external circuit affords a path of low resistance, the E. M. F. at the brushes due to residual magnetism can never rise high enough to send an exciting current through the high resistance shunt field coils. Shunt machines, therefore, should always be started with the main switch open. The reverse is true in compound wound dynamos, and whenever machines of this type fail to excite, it is often possible to make them build up by short circuiting the external circuit at some point near the machine. This should, however, be done carefully, as the voltage comes up very quickly, and there is some danger of burning out the armature. A safe and convenient way of accomplishing this is to take a short length of lamp cord and touch the two ends to the opposite terminals or studs on the main switch. As the voltage begins to rise, the wire can be quickly withdrawn, and the magnetism having once taken hold, will continue to build up until normal voltage is reached. In case of failure to withdraw the short circuiting wire at the proper time, the fuses or circuit breaker connected to the main switch will act and protect the machine.

(7) Short circuits in dynamo. If certain portions of the windings or connections in a dynamo be short circuited there will not be sufficient E. M. F. generated to send an exciting current through the field coil. These short circuits may occur in the terminals through metallic dust bridging over the insulation, or by two or more terminals of opposite polarity being grounded on some part of the machine frame. The brush holders may be short circuited on the rocker arm through the same causes. Short circuits may also occur in the field coils or field circuit.

The usual test with an ordinary magneto will locate the first two, and if the short circuit in the field arises from parts of the coil being grounded on the frame, the magneto will also locate this. If the short circuit in the field coil is a partial one only, produced by deterioration of the insulation, a resistance test is necessary. A coil which has become oil saturated is generally subject to deterioration of this kind, and the only remedy is to rewind the coil. If coils become saturated with oil they can be cleansed by removing

from place and soaking in naphtha. This will remove all traces of the oil. The coils will quickly dry and the insulation will be preserved.

Sparking at the Brushes:

This trouble seldom exists nowadays in a well designed dynamo in good condition, working on a normal load. If the air gap be too small or the number of turns per section in an armature too great, change of load will require change of brush position to prevent sparking. Occasionally, in the haste to deliver and erect a dynamo for a steamship in the short time usually allowable for such work, errors of construction are more liable to creep in than in the case of dynamos intended for land service. An instance which resently came under the observation of the writer was a machine which sparked badly on changes of load. The company which built it and the company which installed it each had an expert trying to locate the trouble. The writer finally discovered that the armature core was a little too large in diameter. This was shown by the small exciting current required owing to decreased air gap. On removing the armature and boring out the field cavity, the trouble was remedied.

The causes of sparking in a well designed machine are:

(1) Bad adjustment of brushes. It sometimes happens that brushes are not in their proper positions on the rocker arm. In this case, some of the brushes will operate sparklessly, while there will be sparking at the others. To remedy this, the rocker arm should be placed in the position where the greatest number of brushes are sparkless. The other brushes should then be adjusted on the rocker arm in such position that they will cease to spark.

(2) Bad condition of brushes. If the brushes do not fit well on the commutator, or if their contact surfaces are covered with dirt, or oil, there will be poor contact and consequently sparking. The remedy is to form the brush tips to fit well on the commutator and clean the brushes thoroughly.

(3) Vibration. If a machine is only loosely set on its foundation, or is driven by a belt with a bad joint in it, or is subjected to vibration from any other cause, the brushes will jump slightly in the brush holders, causing a small spark, and making a small pit on the commutator bar. The continuation of this process will so roughen certain commutator bars, that the sparking as they pass under the brushes will become very bad. The remedy, of course, is to bolt the machine down solidly and remove the cause of vibration.

(4) Bad condition of the commutator. If the commutator is rough, has loose segments, or turns eccentrically, either because of its own distortion, or the bending of the shaft, the brushes will be caused to jump and sparking will result. These faults may be determined by inspection, and the remedy is to put the commutator or shaft in proper condition, generally by turning down. The commutator should be finished up with file and sand paper, or carborundum paper. Emery should never be used.

(5) Overload on dynamo. Whenever an overload takes place, the armature reactions which vary with the load become so great and the heating at the point of contact of the brushes with the commutator so intense, that sparking will take place. Overload nearly always arises from accidental short circuits. These may occur at the machine, but will generally be found in the external circuit. A test of the lines with all the lamps turned off and the main switch open, made with a magneto, will determine whether or not the fault is in the external circuit or in the machine.

(6) Open circuit in armature. If there be a broken circuit in the armature, sparking will take place which no brush adjustment can suppress. Generally this fault will show itself by producing a flat place on the commutator surface, this flat being usually produced on commutator bars which are connected with that portion of the armature in which the broken circuit exists. An open circuit in the armature is also usually shown by the color of the commutator bar connected to the coil in which the open circuit occurs, which turns a dirty black. Often the bar is both flatted and darkened, in which case the open circuit is unquestionably shown.

Usually the break takes place in the connections leading down to the commutator bars. If the break be only partial, the faulty coil may be located by passing a heavy current into the armature through the brushes from some external source of supply. This coil will be found cooler than the other coils in the armature. An annoying form of defect is the "flying" open circuit. This nearly always takes place at a lead connecting an armature coil to a commutator bar. When the armature is in a position of rest, no break or opening in the circuit is discoverable. When the armature is rotating the lead may be pulled out of contact with the bar or with the coil, due to the action of centrifugal force or the magnetic drag on the lead, or to both forces combined. It is very difficult to locate this defect as tests can only be made when the armature is at rest, and the open circuit only exists when the armature is rotating. (It is obvious also that short circuits may be of this same character.) The only method of locating this trouble is to examine carefully each of the leads and discover if sufficient looseness exists for any action of this sort to take place.

(7) Short circuits in armature. Except in the case of a "flying" short circuit as just mentioned, an armature short circuit can usually be located by running the dynamo on light load, then shutting down and feeling the coils. The short circuited coil will be found much hotter than the others. A better test is to excite the field magnets from some external source of supply, raise the brushes from the commutator, and run the armature for a short time. All the coils will be found cool except the short circuited one. Another method of locating this fault is to connect a battery across the brushes and then measure the fall of potential by means of a galvanometer or low reading volt meter between adjacent segments all around the commutator. The short circuited coil will be located by finding the two segments across which the fall of potential is very small as compared with the fall between the other adjacent segments. This latter test will not locate a "flying" short circuit nor will the second one mentioned, if it is dependent on the magnetic drag on the leads when they are carrying a heavy current.

(8) Short circuits or disconnections in the field coils. If an open circuit exists, it may readily be detected by means of a magneto or galvanometer. A short circuit in a field coil will be indicated by the faulty coil being

cool along some portions of its length and hot in others, unless the short circuit is from one end of the coil to the other in which case the entire coil will be cool as compared with the temperature of the good coils which become overheated. If the short circuit be due to deterioration of insulation, the entire coil must be rewound. If the trouble is produced by two or more grounds, the coil may be repaired. It is seldom, however, that double grounds are formed inside the field coils. These will usually be found in the connectors leading from the brushes to the flanges of the field spools.

A partial open circuit can only be detected by a resistance test. A rough method is to disconnect the field coils and send a current through each separately from a battery. An ammeter or galvanometer must be connected in the test circuit. If the instrument gives equal deflections for each coil tested, there is no disconnection. If one coil shows a smaller deflection than the others, some form of disconnection exists. If the instrument shows a greater deflection on one coil than on the others, some form of short circuit is present.

(9) Brush too wide. If the brush is wide enough to cover more than two commutator bars, it will short circuit, both the coil being commutated and one adjacent thereto. This will cause an abnormal current to flow in the coils when their commutator bars pass under the brushes and sparking will result.

(To be continued.)

Mark Twain as Chief Engineer.

Editor of MARINE ENGINEERING:

Recently I read an interview had with an old Mississippi river boat captain, Thomas Bixby, under whom Samuel L. Clemens (Mark Twain) served as pilot and engineer. The captain's description of "steamboating" on the good boat *Swallow,* and especially of her engine, is so interesting that I take the liberty to enclose to you that part of the interview. H. L.

Kansas City, Mo.

"The *Swallow* had the queerest sort of engine that was ever seen," said Captain Bixby. "The craft itself was a little shaky—it only plied between St. Louis and Cairo—being about 30 ft. long, with a stern wheel, a place for freight and passengers, a pilot house, and a place on what may be called the pilot deck for the engine. That engine went aboard when it was needed and only then. It burned no wood nor coal, but ate a powerful sight of grass. It was a large gray mule named Jerry which worked a treadmill that propelled the boat. Sam Clemens—you know his name of Mark Twain came later—was chief engineer and pilot. He had a system of signals and they were ingenious. By pulling a cord he could raise a head of cabbage just out of reach of the mule. The engine would start for it and begin to walk after it and the boat floated majestically on down the river or up, as the case might be. When Sam wanted to stop he would pull a rope attached to the feedbox of the engine.

"Without intending to be personal, I will say that Jerry was one of the most intelligent animals I ever met. His voice was more on the order of a foghorn than a whistle—it was too much of a baritone for the latter.

"When Sam wanted to whistle for a landing he hit Jerry with a stick. If he wanted in the profane language of the river pilot, to go ahead like h——, he gave Jerry a touch of the whip."

S.S. RANDOLPH S. WARNER.—The steamer *Randolph S. Warner,* recently launched at the yard of the Superior Shipbuilding Co., is built for the R. D. Hanna Co. for ore carrying trade on the Lakes. The dimensions are: Length over all, 366 ft.; beam, 42 ft.; depth, 26 ft. 6 in.

LAUNCHES—HOME AND FOREIGN.

S.S. ACME.—The tank steamer *Acme,* belonging to the Standard Oil Co., was recently launched at Bath, Maine. She is of the following dimensions: Length, 332 ft.; beam, 45 ft. 4 in.; depth, 26 ft. She is built to carry 1,500,000 gal. of oil to the East Indies and China.

S.S. FRANK H. PEAVEY.—The first of the fleet of the Peavey syndicate, the *Frank H. Peavey,* was recently launched from the Lorain yard of the American Shipbuilding Co. The steamer is 450 ft. over all, 50 ft. beam, and 28 ft. 6 in. deep. She will be propelled by quadruple expansion engines, cylinders 15 in. 23 3-4 in., 36 1-2 in., and 56 in. with stroke of 40 in. Steam will be supplied by two Babcock & Wilcox boilers.

S.S. EL DIA.—The new Morgan Line steamship *El Dia* was launched on May 18, at the yard of the Newport News Shipbuilding and Dry Dock Co. Her principal dimensions are: Length over all, 406 ft.; perpendiculars, 380 ft. 8 1-2 in.; beam, molded, 48 ft.; depth, molded to awning deck, 33 ft. 9 in.; gross tonnage, 4,608 tons. The engines are triple expansion with cylinders 33 in., 52 in. and 84 in. dia. by 54 in. stroke. Steam is supplied at 180 lb. pressure by three double ended Scotch boilers 13 ft. 10 in. dia. by 20 ft. 6 in. long.

SUBMARINE BOAT FULTON.—The submarine boat *Fulton* was launched from the yard of Lewis Nixon, Elizabethport, N. J., last month. She was christened by Miss Muriel Rice, a daughter of the president of the Holland Torpedo Boat Co. The boat is similar to the *Holland* with the exception of being somewhat larger and being fitted with more powerful engines. The *Fulton* is of these dimensions: Length, 63 ft. 4 in. and 11 ft. 9 in. dia. The boat, when submerged, will displace about 120 tons.

S.Y. IRENE.—The steam yacht *Irene,* built by the Gas Engine and Power Co. and Chas. L. Seabury & Co., was launched at Morris Heights. The principal dimensions of the yacht are: Length over all, 150 ft.; length on water line, 130 ft.; beam, 18 ft.; draft, 8 ft. She has two sets of triple expansion engines and Seabury water tube boilers. The yacht is of steel throughout and the joinery is mahogany. The dining saloon is in the forward deckhouse. The social hall or music room is located in the after deck house, from which stairs lead down to the owner's quarters and guests' rooms which are all handsomely furnished. The *Irene* belongs to Mr. George Lewisohn.

TURBINE STEAMER KING EDWARD.—The first passenger steamer to be fitted with steam turbines was launched at the yard of William Denny & Bros., on the Clyde, and christened the *King Edward.* The dimensions of the vessel are: Length between perpendiculars, 250 ft.; beam, molded, 30 ft.; depth to promenade deck, 17 ft. 6 in. The machinery consists of three Parsons steam turbines, each on a separate shaft. The central shaft has one propeller, driven by the high pressure turbine, and the outside ones, carrying two propellers each, are driven by the low pressure turbines. Steam is supplied from a double ended boiler. The boat is expected to make 18 to 20 knots upon low coal consumption.

TECHNICAL PUBLICATIONS.

STEAM BOILER ECONOMY—A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers. By William Kent, A.M., M.E. Pages 458. Size 5 1-2 by 9 in. New York, John Wiley & Sons.

The author of this book has had almost a lifelong acquaintance with his subject and is therefore exceptionally well qualified by training and experience to prepare such a work as he now gives to the engineering public. While in most books on the subject of steam boilers the leading place is given to descriptive matter, especially as bearing on the varieties of form, details of construction, etc., the present work gives rather the leading place to the points which affect more directly the question of the economy of performance.

The book is divided into seventeen chapters covering the following principal topics: The chemistry of fuel and its combustion; coal and the coal fields of the United States, with a discussion of the tests of the heating values of American coals; special fuels other than coal; furnaces and fittings, firing, smoke prevention, etc.; a general discussion of the action of boiler heating surface, and of the relation between the various factors which affect the efficiency of such action; the principal types of steam boilers on the market; the points of a good boiler; boiler troubles; boiler tests, with a copy of the code of 1899, adopted by the boiler test committee of the A. S. M. E., of which committee the author was a member; tables of the properties of water and steam, factors of evaporation, etc.

Of these, the chapters on the coal fields of the U. S. and on the tests of the heating values of coal are especially full and will be found of great value to those interested in these topics. The discussion of the question of steam boiler efficiency is introduced by a general discussion of the problem, following somewhat the methods of Rankine. This introduction is largely mathematical, and will only appeal to those who readily follow discussions requiring the higher mathematics. A general formula is derived involving the various quantities on which efficiency depends, and containing one so-called "coefficient of performance." It may perhaps be doubted whether this formula will do all the author hopes. The variability in the various quantities, especially those not directly measurable, and cared for by the coefficient of performance, is so great that it may be questioned whether the one coefficient will be able to provide for all their vagaries. This general discussion, however, is based on the well known laws of heat and will serve to show the general relation between boiler economy and the conditions on which it depends. The chapters on the types of boilers found in American practice, and on furnaces, firing, etc., are freely illustrated, the selections in the main having been made with good judgment.

The author of the book is no novice in engineering writing, and possesses a clear and logical style, which is plainly in evidence in the present work. His experience has been such as to give him unusually good opportunities for acquiring the training and the material needed for the preparation of such a book, and the result shows that these opportunities have been used to most excellent advantage. The binding and typography are in the excellent and standard text book style of the publishers. The book may be most heartily recommended to all who are interested in steam boiler plants and in the economical generation of steam for power, or for any other purpose requiring the use of the various modern forms of the steam boiler.

STEEL TUNNEL.—On June 8, a steel tunnel 12 ft. 6 in. dia. and 225 ft. long, was launched at the Crescent Shipyard, Elizabeth, N. J. This tunnel made of two steel cylinders, one within the other, is to be sunk in the East River opposite Thirty-ninth street, New York city, for conveying clear water from the middle of the river to the condensers of the great electric plant built at that point.

STEAMER OVERTURNED.—The steamer *Hudson* of the Merchants' and Miners' Line fell over upon her side while being hauled out of water for repairs, and was badly damaged at the bow. Water flowed in through the hole so rapidly that the largest steam pumps available were not sufficient to keep the ship clear. Efforts to right the ship have, up to date, been unsuccessful and she is gradually sinking deeper in the mud.

SELECTED MARINE PATENTS.

674,597. LIFE-SAVING BOAT. CHARLES BUCKEL, SAN FRANCISCO, CAL.

CLAIMS.—A cylindrical conical-ended exterior vessel with interior shell suspended by longitudinal axle and rollers to exterior shell; means of ingress and egress, ventilation, light, and propulsion and controlling machinery.

674,609. ACETYLENE GENERATOR. JOHN A. MOSHER, CHICAGO, ILL.

674,638. FEED-WATER HEATER. JOHN E. SCHLIEPER, ALLEGHENY, PA.

CLAIMS.—A combination with a casing or shell a series of pans over which the water flows; a hollow column having steam outlets in its sides, and a water spraying device for distributing the water on the upper pan.

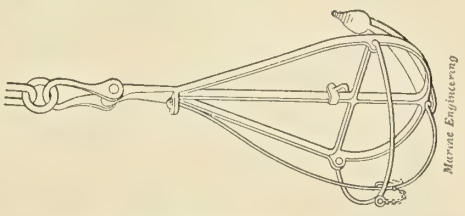
674,683. ELECTRO MAGNETIC VALVE. NILS O. LINSTROM, NEW YORK.

CLAIMS.—A combination of an electro magnet with two armatures one of which controls a supply port and the other an exhaust port, one armature to move before the other.

674,819. DIRECT-ACTING AIR PUMP. FREDERICK M. WHEELER, MONTCALM, N. J.

CLAIMS.—A cast cylinder in line with and directly beneath a steam pump; inlet valves to cylinder at the lower side, and outlet valves on top of cylinder, all valves with covers for easy access.

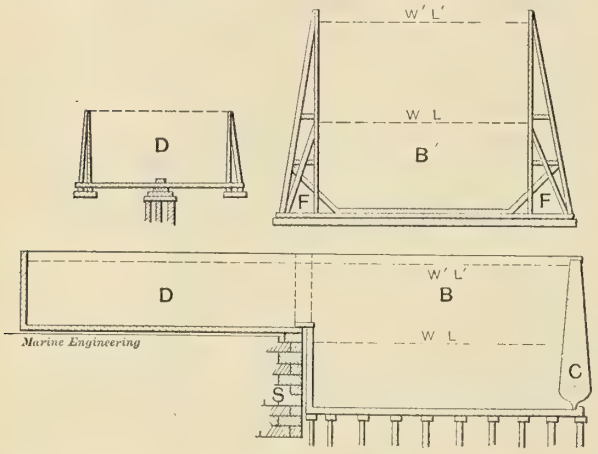
674,839. ANCHOR. DONALD M. HASTINGS, SAN FRANCISCO, CAL.



CLAIMS.—An anchor including a central and side shanks united in same plane, with fluke projecting from one side, and foldable bowed extension from opposite side of shank.

664,844. DRY DOCK. ORLO EPPS, WASHINGTON, D. C.

CLAIMS.—An invention for dry-docking vessels by means of a floating basin. The one or more docks *D*, are built entirely above the water line with strong walls



for retaining the water when pumped in. The basin *B*, has side walls with compartments *F*, *F*, for floating or sinking it, and a removable floating caisson *C*. The method for docking a vessel is: sink the basin in front of the dock till it rests on the piling at the bottom; bring the vessel within the basin; close the basin by placing the caisson at the end of basin; pump the basin and dock full of water up to the level of *W' L'*; float the vessel into place in the dock, securing her with keel and bilge blocks; let the water flow out of basin and dock. The vessel will then be above water line, on shore. This method can also be used for launching ships if they be built within a dock of this description.

674,872. MATERIAL OF VALVE-PACKING. ARTHUR NIXON, MANCHESTER, ENGLAND.

CLAIMS.—A combination of asbestos, rubber dough and black fluid of antimony in proper proportions.

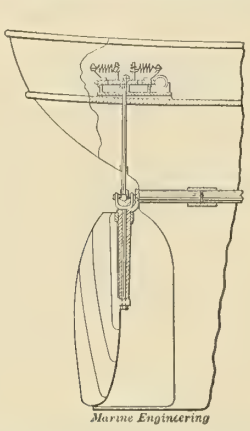
674,901. PROPELLING MECHANISM FOR BOATS. G. F. BRYAN, MEGGETT, S. C.

CLAIMS.—The combination with a small boat of two paddle wheels at the stern, with means for rotating same by hand from within the boat.

675,112. PNEUMATIC HOISTING MACHINE. ROBERT A. RUTHERFORD, PHILADELPHIA, PA.

675,140. METALLIC ROD PACKING. THOMAS G. SEXTON, LEXINGTON, KY.

675,178. APPARATUS FOR PROPELLING AND STEERING VESSELS. HENRY C. VOGT, COPENHAGEN, DENMARK.



CLAIMS.—An apparatus for propelling and steering vessels by means of a driving shaft, oscillating a rudder blade, a steering shaft connected to the rudder blade, and means for controlling the movements of said shafts so as to impart to the rudder blade the motion of a fish swimming.

675,201. BOAT. WILLIAM A. DOUGLASS, MONROE, WASH.

CLAIMS.—The combination with a boat for navigating narrow streams, a large wheel propelled by machinery, which may be lowered through a well in the middle of the hull when the boat strikes the bottom of the stream.

675,269. LIFE SAVING DEVICE. JOSEPH DUNKEL, FRANKFORT-ON-MAIN, GERMANY.

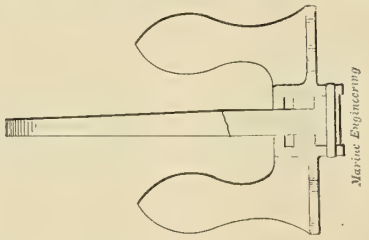
CLAIMS.—A hollow spherical chamber for accomodating human beings, with means of ingress and egress, and means for changing the center of gravity.

675,471. BALL BEARING FOR SCREW PROPELLERS. L. S. GARDINER, NEW ORLEANS, LA.

675,477. PROPELLER. C. E. HALL, MEXICO, MEXICO.

CLAIMS.—A propeller-wheel having a series of ribs extending upon opposite sides of the blades, the central ribs being of greater height than the others,

675,552. ANCHOR. WALTER S. BICKLEY, CHESTER, PA.



CLAIMS.—In a stockless anchor a combination with a base and flukes, a cylindrical trunnion holding both together.

675,563. PROPELLER. K. G. JOHNSTON, PIQUA, OHIO.

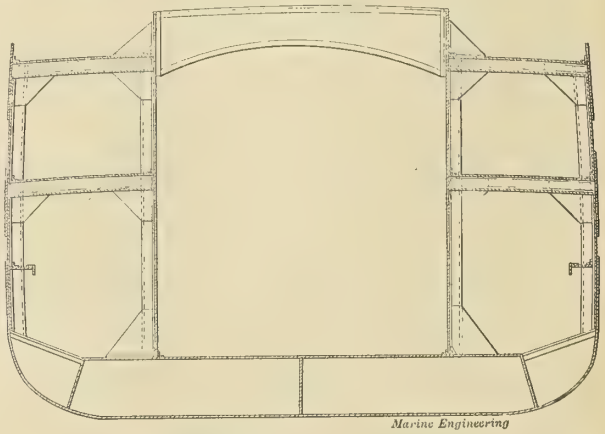
CLAIMS.—A propeller shaft provided at its outer end with channels and a sleeve for mounting the blades of the propeller.

675,639. COMPOUND OF MATTER FOR ARTIFICIAL FUEL. L. PATRY, MONTREAL, CANADA.

CLAIMS.—A composition consisting of crude petroleum, potash, common asphalt, unslaked lime and peat.

675,705. ANCHOR. FREDERICK BALDT, SR., CHESTER, PA.

675,812. NAVIGABLE VESSEL. JAMES CAMPBELL, LONDON, ENGLAND.



CLAIMS.—A cargo vessel having double sides and bottom, and a central longitudinal trunk or hold unobstructed from front to rear and having vertical side walls parallel throughout their entire length and unobstructed from bottom to top, for purposes of carrying heavy cargo.